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THE ELECTRICIAN:

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NOTES.

With the present week's issue of *The Electrician*—the first of a new volume—some alterations will be noticed in its make-up and general appearance, which we feel sure will be welcomed by our readers. The journal is enlarged by four pages, the paper on which it is printed is better, and its letterpress, besides being improved, has been readjusted with a view to giving greater freedom in the distribution and treatment of its miscellaneous contents. Some further improvements are contemplated, which will be noted in due course.

Naturally the gas journals are not friendly to our proposed Electrical Engineering Association, and they gladly avail themselves of the objections urged against it by *Engineering* in the article on which we commented last week. We are glad to notice, however, that a fairer tone pervaded a subsequent leader on the same subject in the last-named journal; and we entertain a hope that when it has taken the trouble to ascertain more exactly what the objects of the scheme really are our contemporary may adopt a more friendly attitude towards it.

In reference to the last chapter of the papers on the "Rise and Progress of Telephony in the United Kingdom," Prof. Silvanus Thompson writes us to point out that the quotation (on page 533) from his evidence at the trial of the United Telephone Company *versus* Harrison, Cox-Walker is not an accurate version of what he actually said. The sentences in question were quoted by the writer of the article from an abridged report in a contemporary journal. From the transcript of the shorthand writer's notes it appears that what actually took place was the following:—

Mr. Justice Fry: What you say is this: When you used it in a manner it was not intended you might occasionally get out articulate sounds?

Prof. Thompson: I think he *did* intend it to speak.

We gladly take the opportunity to amend the quotation, but may add that the writer of the article was not disputing the fact or the intention of Reis to make a speaking telephone. The question was whether the *modus operandi* was by actual make-and-break or by microphonic action; and the argument tended to show that while Reis aimed at a make-and-break his success was due to a microphonic effect. The quotation from the evidence of Prof. Silvanus Thompson, even in its amended form, does not upset this argument.

The chairman of the Imperial Continental Gas Association, being questioned at its half-yearly meeting as to the reasons the company had for undertaking the lighting by electricity of the Burg Theatre at Vienna, replied that there were special circumstances which rendered that course desirable. He did not state precisely what those circumstances were; but he furnished one reason, which he seems to have thought good enough to satisfy the dissentient English shareholders. This was that "if we can show our [electric lighting] competitors what the cost of an electric lighting station is, and what return it is likely to give, they will not be so ready to enter the field as they otherwise would be." A shrewd suspicion that this might be the ingenious motive of certain gas companies nearer home in seeking powers to supply the electric light may have induced the Board of Trade some time ago to refuse their applications. We entertain no doubt that the gas companies will one day be glad to take up their competitor's business, not for the purposes of discrediting it but of working it for profit. Meanwhile, nobody will attach much value to their estimate of what an electric station ought to cost or what the profits are likely to be.

Since writing the above note we came across the following telegram in the colums of a daily contemporary, which we add without further comment:—"Disputes have again broken out between the Imperial Continental Gas Company, which supplies the electric lighting for the Vienna Opera House, and the local authorities, in consequence of which the light supply for the opera has been discontinued and the performances consequently suspended. For some time past the company has been experiencing considerable difficulty in keeping up a regular supply, owing to the defective nature of the boilers, which, yielding to the pressure of the local authorities, the company consented to have made in Austria instead of in England, as they wished. As it is deemed necessary by the authorities to have all the boilers thoroughly overhauled, the result is that the Opera House will be closed for the next fortnight."

The case of Ferranti *v.* Gaulard-Gibbs will not improbably come before Mr. Justice Kekewich within the next few days. It is, in fact, set down for Monday, but whether or not it will be heard on that day is somewhat uncertain. As many of our readers will be aware, the case is one of very great importance for the future of long-distance lighting, although, unfortunately, the issue will scarcely be conclusive as to the patent rights in transformers whichever way it may result. Mr. Ferranti is peti-

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tioning the Court to annul the most important of the Gaulard-Gibbs patents on either or both the grounds of alleged flaws in the specification and alleged impropriety of the subject matter for the grant of letters patent. Proceedings of later date have also been set on foot by Messrs. Gaulard and Gibbs, in which damages are claimed against Mr. Ferranti for infringement of their patent claims.

A rumour from the City reaches us as we go to press that the dispute above alluded to has been settled out of court.

Speaking at Bath last Friday the Chancellor of the Exchequer expressed his determination not to part with the two and a-half millions of revenue which the Post Office annually delivers over to the Treasury by way of profit on the letter-carrying business. We commend this resolution, and hope Mr. GOSCHEN, to quote his own words, will defend the surplus with his life. He regards the inland postage as a very light and unobjectionable instrument of taxation, the net proceeds of which, if applied to the reduction of rates on foreign postage instead of to the relief of the financial burdens of the country, would entail upon the whole of it additional imposts for the benefit of a particular section. Mr. Henniker Heaton will doubtless take note of this. These views, moreover, are similarly applicable to other great corporate industries, notably the great telegram-carrying businesses; and it may be hoped that when next the tariffs of the cable companies are the subject of international discussion, the Chancellor of the Exchequer will defend them on the same business-like principles against those who would appropriate the legitimate rewards of a class which is chiefly English in order to benefit communities which are largely foreign.

According to the *Central News*, whose report on the subject will be found in another column, the effect of the expiry of the Submarine Telegraph Company's cable monopoly to France will be that the British Postmaster-General will have the whole control of the Channel cables in his own hands. Our impression is that this will not be the case. The Submarine Company having actually obtained an extension of its concession for another fifteen years, neither the British Post Office nor anybody else other than the Submarine Telegraph Company will be able to land cables on the French coast without the permission of that company. If this view be correct the matter is one for mutual arrangement between the parties.

The paper on Primary Batteries, for illuminating purposes, read by Mr. Perry F. Nursey before the Society of Engineers on Monday evening, presented a useful compendium of the various attempts which have of late years been made to solve the problem in question. Mr. Nursey was doubtless well advised when he declined to attempt any criticism of the relative merits—or demerits—of these batteries. The fraternity was there in full force, and eager for the blood of any one who dared to find an imperfection in their respective inventions. As it was, they had no grounds of complaint, for, as Mr. Nursey was careful to explain, the descriptions and figures were those furnished by the inventors themselves. The description of one cell which is even capable of running lamps of different candle-power on the same circuit was evidently quoted from a recent article in one of the daily papers. The old *ignis fatuus* of residual products was again trotted out in fine form; and it was really very unkind of Mr. Preece, in the subsequent discussion, to mention the fact that even at the General Post Office, where several hundred thousand cells are in use, the residual products can never so much as be made to pay for the cost of collection. There is one cell, however, which really does appear to us to have a chance in this direction, if we rightly understand the claim made by its representative. This remarkable cell was stated to use 500 per cent. less nitrate of soda than a certain other cell which was mentioned. If this means anything, it indicates that for every pound of nitrate of soda used in the latter, the former produces 4lb. of the same salt. Several of the batteries mentioned by Mr. Nursey were, of course, of considerable value in their proper spheres. They may generally be recognised by the fact that their inventor's claims for them are of a modest character. A man who is a sufficiently good electrician to produce a really practical and efficient primary battery is far too good a one not to know that as regards electric lighting the sphere of the primary battery is very limited in point of scale, although it may be wide in extent.

Apropos of primary-battery-ism, a rather interesting fact was mentioned to us by one of the audience who had listened to Mr. Nursey's paper. He was thinking, he said, of putting in a P.B. for lighting a small house, and with that end in view went to sundry of the companies to inquire as to the cost and other details of their respective "systems." He said that in several cases their respresentatives seemed quite unable to grasp the idea that he actually wanted to *buy* a battery—the possibility of such a proceeding never seemed to have entered their heads; so they tried to persuade him that he really must be mistaken, and that what he actually wanted was to take shares in their company, which they could assure him, &c., &c.

A little consideration is, we fear, sufficient to show that the "residual products" idea in primary battery lighting is based upon what is, perhaps, little better than an economic fallacy. For, supposing that a battery had been devised in which the residual products were of sufficiently high value to pay the cost of collection when working upon a sufficiently large scale, then it is obvious that the whole of this cost could be saved by carrying out the same chemical operation at one spot. But it is certain that the chemical process would then be carried out under conditions very far more favourable to economy than in the makeshift style of a battery cell. We should thus have to set off the value of the light obtained against the diminished cost of the residual products when made on a manufacturing scale. It is obvious from these considerations that the chances in favour of the permanent value of the residual products must be in general very small indeed. The most favourable chance on record was probably that of the chromate of calcium cell devised many years ago by Mr. D. FitzGerald. We believe we are correct in saying that this

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battery practically created the market for its own bye-product, with the result that, as soon as the demand was felt, other processes were introduced, which soon brought the value down to a point where any further competition on the part of the battery was hopeless.

Projectors.—It is stated that the Peninsular and Oriental Steam Navigation Company have given an order for twelve Mangin projectors to MM. Sautter, Lemonnier and Co.

Submarine Cables.—The *Leisure Hour* for November contains an article by Mr. J. N. Porter, giving details of the principal submarine cables and the land-lines in connection all over the world.

Telegraph Stores Required.—Tenders for the supply of telegraph stores have been invited by the following companies:—The Midland Railway Company, the South Indian Railway Company, and the Cheshire Lines Committee.

The Union Bank—Messrs. Elwell-Parker (Limited) are supplying to Messrs. B. Verity and Sons two 12-unit dynamos, and 106 large cells for the Union Bank of London installation, which we hear is approaching completion.

Club Lighting.—The new Isthmian Club, in Piccadilly, which was opened on the 1st inst., is lit by Ferranti transformers, supplied with current from the Grosvenor Gallery. The wiring and fittings were supplied by the Woodhouse and Rawson Company.

Electric Tramways in Brazil.—The *Rio News* says that a proposal for a thirty-years' privilege for an electric tramway in Petropolis, put forward by Mr. Albert Hargreaves, has been referred to the provincial assembly by the president of the province of Rio.

The Electric Light in Brazil.—Mail advices, dated Rio de Janeiro, October 15, state that a new electric company, called the Companhia Força e Luz, was organised on the 10th of October, its principal object being the supply of electric light for private consumption.

Electric Traction at Cologne.—MM. Huber and Herebrand, of Ehrenfeld, have recently placed electric cars upon the tram lines at Cologne. The batteries were furnished by the Electric Power Storage Company. The preliminary trials are said to have been successful, but we have no further details at present.

Country House Lighting.—We understand that the installation erected some years back at Lord Armstrong's mansion, Cragside, is being considerably extended and improved. Messrs. Drake and Gorham are carrying out the work, in connection with which fifty-three of their largest type cells are to be used.

The "Phil. Mag." for November.—This month's *Phil. Mag.* contains an interesting paper by Prof. E. Edlund on the (so-called) Unipolar Induction. The only other paper of an electrical character is a reprint of Mr. Fitzpatrick's British Association paper, "On the Action of the Solvent in Electrolytic Conduction."

Bank of England.—The extension of the lighting is progressing rapidly. We understand that the new plant consists of a 20 horse-power Marshall horizontal engine and boiler and two Elwell-Parker 18-unit dynamos. A battery of Drake and Gorham's accumulators will also be employed in connection with each circuit.

St. Leonards.—At a banquet given in this town by Mr. Wilson Noble, M.P., the borough member, to the corporation and borough officials on the 1st inst., the entertainment, which took place at the Grand Hotel, was lighted exclusively by electricity. The local newspapers speak of the installation in terms of the highest praise.

A Disputed Claim.—A case of some interest is to come before the Courts next week, in which Messrs. Sharp and Kent sue M. F. D'Humy for the recovery of a sum amounting to over £100 for carbon plates supplied for use in his water primary battery. M. D'Humy sets up a counter-claim for damages to the extent of £1,000, on the ground that the carbons were bad.

The Clamond Incandescent Gas Light.—We are informed that the installation of "Clamond" incandescent gas lights, employed at the Guildhall on Wednesday last, is the first of the kind in this country. The work was carried out by the Æolus Waterspray Electrical Engineering Company. Each 40 candle-power burner on this system consumes only 6ft. of gas per hour.

Professor Stokes.—The University of Cambridge has chosen the President of the Royal Society as candidate for the Parliamentary seat vacant through the death of Mr. Beresford-Hope. If Prof. Stokes is elected it will be the first occasion on which either of the two great seats of learning has chosen a scientific representative since the time of Sir Isaac Newton, who sat for the Cambridge University in 1688.

Presidential Address at the Institution of Civil Engineers. The opening meeting of the session of the Institute of Civil Engineers was held on Tuesday, the 8th inst., when Mr. G. B. Bruce, president, delivered his inaugural address. Mr. Bruce made a general survey of the progress of engineering during the last fifty years, and concluded by referring briefly to the enormous changes which have followed from the industrial application of electricity.

The Direct Acting Edgerton Electric Pump.—The Edgerton Electric Motor Company, of Philadelphia, is making a speciality of a motor combined with a direct acting high-pressure pump. The pump is of special design, and is double-acting coupled direct to the motor, and works under a pressure of 42lb. to the square inch. A half-horse power plant has a capacity of 300 gallons per hour, and occupies a floor space of 3ft. by 10ft. A considerable demand is found to exist where current is available.

Tenders for Theatre Lighting.—A correspondent writes from Madeira:—"I shall feel much obliged if you will kindly draw the attention of your numerous readers to the fact that the Municipality of Funchal have published an advertisement in the *Diario de Noticias*, inviting tenders for lighting the new theatre 'D. Maria Pia,' and the City of Funchal with electric light. Applications for plans and all particulars should be addressed to the President of the Municipality, the Visconde do Ribeiro Real, Funchal, Madeira."

A Pretty Lecture Experiment.—A ring of copper is placed round the neck of an empty corked bottle, which is further weighted till it will just sink, neck downwards, when placed in a larger glass vessel of water. Round the lower part of the latter are wound a few turns of insulated wire. When an alternating current is passed through the wire the flask will be seen to rise, owing to the repulsion between the currents in the wire and those induced by them in the ring. The experiment is due to Prof. Elihu Thompson.

Adelaide Jubilee Exhibition.—We have pleasure in announcing that Messrs. Robey and Co., Globe Works, Lincoln, have been awarded six first prizes at the Adelaide Exhibition for their horizontal automatic engines, compound portable

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engine, portable winding engine, wrought angle iron-framed thrashing machine, patent Robey winding engine with wrought iron tank foundations and centrifugal pumps.—We are also glad to learn that Messrs. Ransomes, Sims and Jefferies (Limited), of Ipswich, have been awarded the first order of merit for their exhibits, which include portable steam engine, vertical engine and boiler, single and double furrow ploughs, patent chilled ploughshares and horse rakes.

Electric Light Statistics for Germany.—According to Dr. Schilling, the number of electric light installations in the thirteen principal towns of Germany has increased during the last two years from 131 to 604; the number of arc lamps has increased from 591 to 3,280, and the number of incandescents from 10,403 to 50,469. The number of gas lamps in these thirteen towns is 1,221,882, and therefore, lamp for lamp, electricity furnishes about 4 per cent. of the total illumination. In Munich this proportion is as high as 8 per cent. According to another authority there are in Hamburg at the present time 78 installations of electric light; 325 arc lamps and 5,300 incandescents. About 1,000 horse-power is employed for these installations, of which one-fifth is furnished by gas engines.

The Society of Arts.—The first meeting of the one hundred and thirty-fourth session of the Society of Arts will be held on Wednesday, the 16th November, when the opening address will be delivered by Sir Douglas Galton, K.C.B., D.C.L., LL.D., F.R.S., Chairman of the Council. The papers so far arranged for which relate to subjects of interest to our readers are as follows:—November 23rd, Prof. Silvanus P. Thompson, on "The Mercurial Air-Pump." December 14th, Sir Philip Magnus, on "Commercial Education." A course of Cantor lectures on "Alloys," by Prof. W. Chandler Roberts-Austen, F.R.S.; and two juvenile lectures on "The Application of Electricity to Lighting and Working," by Mr. W. H. Preece, F.R.S, which will be given during the Christmas holidays.

Birmingham.—The "Wild West" Show has "moved," and is now performing at the Aston Grounds, Birmingham. At present the performance is only during the daytime, but by next Monday it is expected that the electric light will be in operation, and night performances will then commence. The electric light arrangements are practically the same as at the American Exhibition at West Brompton, and consist of ten large projectors, each taking a current of 50 amperes supplied from two Victoria dynamos. Either of these machines is large enough to light the total number of lamps by itself. The contract for this work has been entrusted to the United Electrical Engineering Company (Limited) (Messrs. Manville and Madgen). This firm has undertaken to get the light running by Monday next, although the order was only received on Saturday last.

The Lighting of the Monnaie Theatre at Brussels.—The installation at the Monnaie Theatre at Brussels possesses a feature of considerable interest in the fact that the current is supplied by accumulators in the basement of the building, which are charged by machines situated at a distance of 4 kilometres. The number of lamps employed exceeds 600, varying from 8 to 30 candle-power, with a terminal potential of 110 volts. Very elaborate switching arrangements are made for the lighting of the stage. The generating station is situated next to the gas works at Laeken, where an Armington-Sims engine of 80 horse-power drives a 30-unit Gérard dynamo giving 15 amperes at 2,000 volts. This machine is separately excited by two smaller Gérard machines of 110 volts. The commercial efficiency of the system is given as 88 per cent. The dynamos are in duplicate, but there seems to be only one engine. The effect in the theatre has been to reduce the temperature from 45°C. to 18°C., and great satisfaction is expressed with the result.

Trial of Electric Tramway Car at Paisley.—A local journal says:—Mr. James Gibson, electric engineer, Cartha Works, Paisley, has constructed an electric tramway car, and an experimental run was made on Thursday, on the line of the Paisley Tramway Company from Gauge-street to Williamsburgh. The experimental run was considered highly satisfactory. Eighty storage cells supply current to the motor, which rests on a bogey, placed to the front of, but under, the car, and the bogey also includes the front wheels of the car. This arrangement has been adopted for simplicity in the working of the car, as the one bogey, when the accumulators are exhausted, can be easily taken from the car and a new one put in. The motor makes 1,200 revolutions per minute, and a speed can be obtained from four to fifteen miles per hour. When the car is going at the rate of four miles per hour, it can be brought to a stop within the space of two feet from the applying of the brake. In connection with the machinery there are two systems of gear—the one a combination of friction and teeth gear, and the other teeth gear alone.

The Heriott-Watt College, Edinburgh.—Complete arrangements are being made at the Heriott-Watt College for courses in electricity and electrical technology. Laboratories, with every appliance for systematic practical instruction in physics, and a dynamo and test room with power and all testing instruments are being fitted up in the new buildings. Pending the completion of these the Governors have procured the use of the lecture rooms in Minto House. The former courses in the theory of electricity have been extended, and on Friday last a commencement was made with the lectures on applied electricity. The electric lighting and engineering, and telegraphy and telephony classes are presently to be merged in one. Principal Ogilvie gives six preliminary lectures, after which it is expected that students will be prepared to enter the special branch they propose to take up. Mr. W. Geipel, who is district manager of the Brush Electric Light Corporation, will then continue the lectures on electric lighting; those on telegraphy and telephony being taken up by Mr. Alfred Campbell, of the Electrical Staff, North British Railway.

Hastings.—The Town Council last Friday was the scene of some lively episodes in relation to matters connected with electrical industry. The Roads Committee reported against the application of the South of England Telephone Company for permission to erect two wooden telegraph poles on the east side of Old London-road; also against a request of the Hastings and St. Leonards Electric Light Company that they be allowed to erect overhead wires from the company's works in Earl-street to the Palace and Grand Hotels. On both these reports, which were ultimately adopted by small majorities, a warm discussion took place, in the course of which a ratepayer present had to be turned out for expressing his feelings too strongly. The proceedings were diversified by legal doubts arising in the mind of the Town Clerk as to whether this or that member of the Council was competent to speak or vote by reason of his pecuniary interests in one or other of the local companies affected. As nearly all the Council appear to be holders of either gas, electric light, or telephone shares, the proceedings were proportionately shortened; and subsequently a motion to inquire into the relative purity of gas and electric light was summarily stopped because of the mover being a shareholder in the Electric Light Company.

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A Water-Level Indicator.—Electric water level indicators are as common as blackberries, and we are not prepared hastily to assert that the apparatus about to be described contains anything absolutely novel. However this may be, it is certainly an ingenious device, and additionally interesting as being the work of a schoolboy (W. A. Tucker) sixteen years of age. A hollow ball float is mounted on the end of a long lever, which is pivoted towards the other end on the edge of the tank, so that the short end of the lever projects beyond. When the tank is full the lever assumes a horizontal position; when empty the short end projects upwards at an acute angle. It only remains to allow the short end to close a set of rubbing contacts in its different positions, and thus to transmit signals to an electric bell or annunciator as may be desired. By the use of a closed circuit and a little additional complication it would, no doubt, be possible, with only two wires, to indicate differences of level within a tolerably fine graduation. Mr. W. A. Tucker is the son of a Col. Tucker, of Boston, United States.

The Use of Electricity for Treating Gold and Silver Ores.—On September 16th we mentioned that a new process of dealing with silver ore, which involved the use of dynamos, was being taken up in Nevada. We now learn that the method, which is due to Mr. Molloy, of the Hydrogen-Amalgam Company, consists in placing ground ore in a flat pan containing mercury and water; in the centre of the pan is a porous pot which contains a lead plate in a solution of sulphate of soda. An annular disc surrounds the porous pot and floats upon the surface of the mercury. The material of which this disc is made is not stated; it is, however, caused to rotate very rapidly so as to effect an intimate mixture of the ore with the mercury. The whole of the mixed materials are thus "urged out at the rim of the disc by centrifugal force." Meanwhile, it should be stated that the lead plate in the porous pot is connected with the positive terminal of the dynamo, and the mercury in the pan with the negative terminal. Hydrogen is thus evolved upon the surface of the mercury from the water in the pan, and thus overcomes the tendency to oxidise, or "sicken," as the workmen call it. It is claimed that as much as 40 per cent. more gold can be extracted in this way; and as in addition to this the waste of mercury by oxidation is almost entirely obviated it is clear that the process, if this be true, is one of great practical value. We are, however, under the impression that something very similar has been tried before, though, for some reason or other, no ultimate success was attained.

A Method of Making a Selenium Cell of Constant Resistance.—M. Mercadier promises shortly to explain a new system of multiple telegraphy based upon the employment of the selenium cell, of which, as is well known, he has made a special study. In the year 1881 M. Mercadier first described a method of making a low-resistance selenium cell for use as a radiophone receiver. This method consisted in taking two thin strips of brass, separated by a sheet of paper, and drawing a stick of melting selenium along the edges. It was, however, found that the selenium deposited in this way was very apt to scale or chip off, and, moreover, it was almost impossible to make two cells of this pattern which should have the same resistance. He therefore constructed a somewhat different form of cell, which, although now described (in the *Comptes Rendus*) for the first time, has yet remained unaltered in resistance for over six years, and it has also been found an easy matter to make other cells of the same resistance. A pair of platinum wires are accurately laid down in the form of a double spiral upon a sheet of emery paper. The ends of the wires are attached to two separately insulated blocks of brass upon which the emery paper rests. The whole is then heated to the melting point of selenium, and a stick of that material is drawn around the double spiral. This would scarcely seem to be a very easy mode of constructing a set of identical cells, but in M. Mercadier's hands the results obtained are excellent. Several cells made at different periods since 1881 have each a resistance of about 300,000 ohms, and have not varied since their first measurement.

Notes on the Electric Lighting of the Recent American Exhibition.—The electric lighting of the American Exhibition held during the present year at Earl's Court, with the exception of the search lights in the arena of the Wild West, which were erected by the Anglo-American Brush Corporation, was entirely carried out by Messrs. Laing, Wharton and Down. The Exhibition buildings and grounds were lighted on the Thomson-Houston arc system from seven 50-light dynamos, each giving 2,000 volts and 10 amperes, and two 35-light machines, giving 1,500 volts and the same current strength. The power was obtained from three engines, with an aggregate of 90 indicated horse-power, by Messrs. Hornsby, of Grantham. The installation was carried out under considerable difficulties, as, owing to the delay in getting the shed ready for the reception of the dynamos, it was impossible for the engineers to make a trial run until the very evening of the day on which the Exhibition was opened, when the buildings were cleared for about twenty minutes for the purpose. Everything was found to be in perfect order, and from that time until the closing of the Exhibition the lighting was carried out in the most satisfactory manner. One breakdown only occurred during the whole time of exhibition, and was caused by a tube being blown out of one of the boilers, which necessitated the stoppage of the machines supplying one of the circuits in the building. Even this caused no sensible inconvenience, as the precaution of supplying alternate lamps only from the same circuit had been adopted by the engineers; moreover this cessation was only of about four minutes' duration, as spare machines were immediately switched into the circuit to replace those which had been stopped by the breakdown of the boiler. The Thomson-Houston system of regulation, which is well known to the readers of *The Electrician*, was very severely tested during the first few weeks of the Exhibition. The fitting of the engines, in the first place, was by no means satisfactory, and on some of our first visits to the engine room we have seen as many as three pumps at work throwing water on the bearings to keep down their heating. The action of the Hornsby governors, at any rate as they were run here, did not appear to be sufficient to maintain the steady speed desirable for electric lighting purposes, and this was specially evident when the Thomson-Houston lamps on the mast in the arena of the Wild West were switched on or off, when even the very efficient system of regulation in use was insufficient to prevent flashing. On more than one occasion the engine room was filled with grit from the plugs having been allowed to blow out, and the general state of the engine room, as regards cleanliness, was not such as to excite our admiration, nor probably that of the engineer in charge of the dynamos. The Welcome Club was lighted by incandescent lamps from a Jones dynamo, driven by a 12 horse-power vertical engine. The electroliers were formed of brass and beaten copper in the form of foliage, with lamps shaped like fruit, and excited general attention from their beauty of design.

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ELECTROLYSIS OF IRON SALTS.

BY ALEXANDER WATT.

The electro-deposition of iron, although it has met with some few applications—but more especially in the so-called "steel facing" of engraved copper plates and printers' type—has not yet received so much attention in this country as it deserves. Indeed, iron-plating—which is a better term than *ironing*, which would smack rather of the laundry—and iron electrotyping may be said to be as yet but in their infancy, so far as development is concerned. There can be no doubt that if iron electrotypes could be as freely obtained as we produce those of copper, a very important field of enterprise would be opened up for those who follow the art of electro-deposition. Before this desirable object can be attained the study of various solutions of iron salts, with and without the addition of other substances, must receive further consideration. With a view to aid those who are interested in the electro-deposition of iron generally, I purpose giving the results of a series of experiments which I have made from time to time in the deposition of iron, from which it will be seen that while there are many iron salts from which the metal may be deposited readily and of good quality, other salts are totally unfit and valueless for the purpose. When desirous of taking up any new branch of electro-deposition, it is advantageous to the student, not only to know the nature and behaviour of those materials which are most suitable for his purpose in a practical sense, but he should also have some knowledge of the shortcomings of other salts of the same metal in case at any time he might be tempted to experiment in the same direction himself.

In depositing iron from its various solutions many difficulties have presented themselves which ingenuity has to some extent overcome. The rapid oxidation of the iron salt of the surface of the electrolyte, and the blackening of the deposit at the corners and edges of the plate have, amongst other sources of annoyance, been the most troublesome causes of failure. Again, with some solutions it has been found that the anode did not dissolve with sufficient readiness to keep the bath up to its normal strength. These faults have, however, been to some extent overcome, and so far as light deposits are concerned—such as in the facing of engraved copper plates—the deposition of iron presents but little difficulty. The production of iron electrotypes, however, has yet to receive further development before the process becomes a practical art of general application.

In describing the various solutions of iron which I have electrolysed, with a view to determine what character of deposit they were capable of yielding, it may be well that I should also refer, in passing, to those solutions which have hitherto been employed or recommended for the deposition of this metal. In making up baths from any of the well-known solutions, I would recommend the operator—regardless of prescribed formulæ—always to make his solution a trifle too weak rather than adopt the other extreme, since weaker solutions will often give far better results than stronger ones, and the gradual strengthening of the bath can readily be resorted to if occasion requires it. Too strong a solution of any iron salt is pretty sure to give an indifferent deposit and cause disappointment, whereas with a weaker solution—if it be a good one in other respects—the deposition is merely slow, a fault easily remedied by the *gradual* addition of more iron salt. The alterations of the strength of the bath should never be made, however, until the operator has satisfied himself that the current is adequate. When practical, the solution (proto-sulphate, for example) should be put into such a condition that it will work well with a surface of anode about equal to that of the cathode, when working at the ordinary temperature. With some solutions, however, this would not be practical, as in cases where other salts besides those of iron are used for preparing the bath, which have little or no solvent action upon the iron anode.

Proto-Sulphate of Iron.—Various proportions of this salt to the gallon of water have been employed in making up baths for depositing iron, but I found the following give exceedingly good results with a somewhat weak current: About half an ounce of good sulphate of iron was dissolved in a pint of cold water. One small Daniell cell was first tried, with electrodes of about equal surface, but the deposit was of rather dark colour. A few drops of sulphuric acid were then dropped into the bath, and an extra cell connected, when a considerable improvement in the colour was manifest; a third cell was now added—the whole being in series—when the deposit became exceedingly white and bright, which character it maintained. At the end of about two hours the plate (sheet copper) was withdrawn, when its brilliant appearance resembled that of copper which has been dipped in mercury. There was considerable evolution of hydrogen. On examining the anode (a plate of wrought iron), it was found to have been very equally and very freely acted upon, and presented a very clean surface.

Proto-Chloride of Iron.—A moderately strong solution of this salt did not yield a good deposit; neither was the colour of the film improved by diluting the solution. In all conditions of the liquid the deposited metal had a tendency to blacken after a short immersion of the negative plate. The best results were obtained with two Daniell cells.

Ammonio-Sulphate of Iron.—A solution of this salt, used with a rather weak current, is undoubtedly one of the best for the deposition of iron. The solution is greatly improved, however, by the addition of a moderate quantity of acetic acid. I found the following proportions yield a very white deposit of iron with two small Daniell cells:—Ammonio-sulphate of iron 1¼oz., water one pint. The deposit, though not so bright as that from the proto-sulphate before referred to, was very white and uniform in character; there was no blackening of the film at the corners of the plate, and deposition took place very freely.

Tartrate of Iron.—A solution of this salt was prepared by dissolving recently precipitated hydrated sesquioxide of iron in a strong and hot solution of crystallised tartaric acid. With two Daniell cells little or no deposit took place. With five cells the film was white at the lower part of the plate, but the remaining surface was of a dark colour. The solution is a bad conductor, and not suitable for any practical purpose.

Phosphate of Iron.—Recently precipitated carbonate of iron was dissolved in a strong and hot solution of phosphoric acid. Five cells were used, when a white deposit of iron was obtained upon a copper plate almost immediately. The coating soon became dull, however; and after about half an hour or so the liquid became decomposed, a white precipitate being formed, which settled upon both electrodes and floated about in the liquid. The white salt thus formed was doubtless the protophosphate of iron.

Salicylate of Iron.—A solution of this salt was prepared by dissolving recently precipitated carbonate of iron in a hot solution of salicylic acid, when a deep red liquid resulted, which yielded a tolerably prompt deposit of iron of a darkish colour, but fairly adherent, upon a copper surface. Five cells were necessary to obtain a successful deposit.

Potassio-Tartrate of Iron.—A solution of this salt yielded a tardy but bright deposit of iron, with five Daniell cells. The solution was not a good conductor.

Sulphate of Iron (Klein's Method).—A solution of sulphate of iron is precipitated by means of carbonate of ammonia; the precipitate is then well washed and afterwards dissolved in sulphuric acid, care being taken to avoid excess of acid. The solution is used in as concentrated a state as possible. It is stated that good reguline metal may be obtained from this solution by means of a current from four weak Meidinger cells, with an iron anode and cathode of copper. In working this solution it is important to prevent it from becoming acid, for which purpose an anode eight times larger than the cathode, or receiving plate, must be used, and a plate of copper or platinum attached to it, so that the two form a voltaic couple in the liquid, and thus cause the iron to dissolve when the current is not passing.

Perchloride of Iron.—A solution of this salt does not yield a deposit of iron. In electrolysing a solution of the perchloride,

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very carefully prepared, a white deposit was at first obtained, which, upon examination, gave a trace of iron, but a greater portion of the film was insoluble either in sulphuric or hydrochloric acid. The deposit was probably due to some metallic impurity of the peroxide (rouge) employed, but this I have not yet determined.

Persulphate of Iron.—This salt also yields no deposit of iron by elec rolysis. A copper plate became coated with a dark-coloured film, insoluble in either sulphuric or hydrochloric acid, and was probably due, as in the former case, to some metallic impurity of the hydrated sesquioxide of iron employed—though how such a foreign metal could find its way into the precipitated hydrate is a mystery, since it was prepared from an apparently pure sample of jewellers' rouge dissolved in hydrochloric acid and precipitated by ammonia.

(*To be continued.*)

JEHL AND RUPP'S SYSTEM OF CONTINUOUS CURRENT TRANSFORMERS.

In our issue of October 28th we gave an outline of the somewhat remarkable system of continuous cu rent transformers designed by MM. Jehl and Rupp. From the additional details which we are now enabled to present it will be seen that in working out these principles the inventors have introduced several improvements and modifications, some of which tend no doubt to increase the practical value of the system. We must, however, leave our readers to form their own opinion as to the merits of the system, as we have not had an opportunity of inspecting the apparatus ourselves.

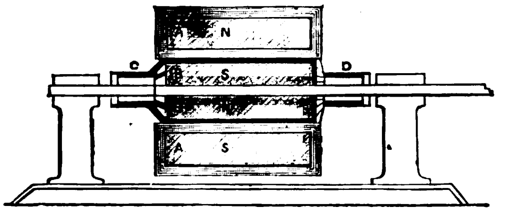

Fig. 1.

In Fig. 1 is shown a longitudinal section of one of these transformers according to the latest design; in this case the "distribution commutator" is done away with. A A represents an iron cylinder wound as a Gramme ring. The sections of the windings are connected to the commutator D, and the brushes bearing upon this commutator are placed in the main circuit which is supplied from the central station with a high tension continuous current. When the ring is rotated its polarity (which may be as shown in the figure) will therefore remain fixed in space, except, of course, for the slight shifting to and fro due to the angular width of the commutator bars.

BB represents a drum upon which secondary coils are wound in the usual Siemens-Alteneck fashion. The sections of this winding are connected with the commutator C seen on the left, and the brushes bearing upon this commutator carry off a continuous current which is employed in the local circuit. The peculiar feature of the arrangement is that the drum is permanently fixed within the ring and the whole rotates together as one piece. The design is therefore precisely similar in principle to the Paris and Scott type of transformer, except that the exciting magnets (the ring) revolve with the armature, while their polarity remains fixed in space. Edison's "rotation transformer" (see *The Electrician*, October 14th, 1887, p. 479) is also based upon identically the same principle, though the details are somewhat different.

The chief drawback to the design obviously lies in the fact that the rotation is not automatic as in the Paris and Scott type, but has to be impressed from some external source. On the other hand, although the output of the machine varies with the velocity of the rotation, yet the power absorbed in driving the shaft is only that required to overcome mechanical friction and, perhaps, some Foucault current effects. In fact, it would be possible to keep the coils at rest, and merely to rotate the brushes.

The "distribution commutator," which we have already described and illustrated, is chiefly of use in cases where a number of rotation transformers are supplied from one sub-central station. A single distribution commutator may then be employed for the whole, and in this case the commutator alone need be rotated, while the transformer remains at rest. The large brushes are connected with the main circuit, and the smaller brushes are all connected with the respective coils of the transformers in parallel. It should be noted in favour of this device that the brushes require no adjustment for lead; they act merely as collectors, and may stand at any point upon the circumference of the commutator. M. Jehl assures us that the commutator is absolutely sparkless in working.

In order to increase the efficiency of the rotation transformers the authors have recourse to a device which, though not new in itself, has never, so far as we are aware, been successfully employed before. It is also probably true that the conditions for its success have never been so favourable as in the present case. This device consists in the employment of an iron conductor for winding the secondary circuit, so as to diminish the magnetic resistance across the ring. Of course, in order to do this, it is necessary to increase

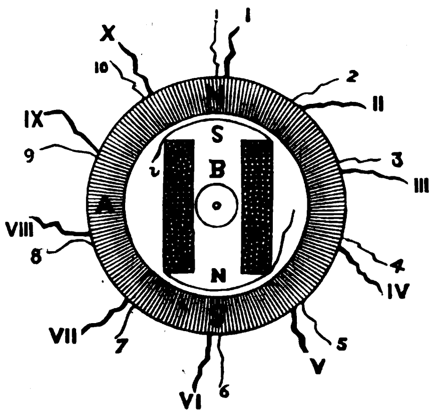

Fig. 2.

the sectional area of the conductor in the proportion of seven to one. In Fig. 1, therefore, the drum is built up of iron cylindrical sectors of exactly the same shape as the bars of a commutator. The cross connections at the end of the drum are made after the fashion of the Edison armature, and must still be of copper to prevent magnetic short-circuiting

By this device the magnetic circuit across the polar diameter of the ring has scarcely any "air gap." There still remain, however, three breaks of magnetic continuity, for the lines have to traverse the primary coils and the central aperture of the drum.

The advantages claimed for the rotation transformer are (1) that it is easier and cheaper to build than the double-wound armatures of the Paris and Scott type; (2) that the insulation between the primary and secondary circuits is greater, and may easily be made very high indeed; (3) that the efficiency is higher owing to the greater magnetic conductivity, and that the rotation of the apparatus as a whole renders it less objectionable for general use.

It will be admitted that the first two claims have considerable weight; but, on the other hand, we have to take into consideration the necessity for using a motor to drive the apparatus. We understand that it is proposed to effect this by means of a small motor placed in the primary circuit. Wherever any kind of motive power is already available this difficulty, however, at once disappears.

The authors have displayed considerable ingenuity in devising a number of modifications in the method of carrying out these general principles. Of these the plan illustrated in Fig. 2 is the most interesting. Here we have a shuttle-wound

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armature, B, which rotates within a stationary Gramme wound ring. The ring A is wound with two independent circuits (I., II. ... X, and 1, 2 ... 10), connected up to separate commutators. The coil on the rotating shuttle is connected in series with the primary windings of the ring by means of a pair of brushes which bear on two collecting rings; the polarity of this shuttle therefore remains constant. The commutators belonging to the primary and secondary windings of the ring are mounted upon the same spindle as the shuttle; consequently, although the ring remains at rest the polarity of the ring revolves with the shuttle. This arrangement is therefore capable of working as a motor (of the Ayrton and Perry type). At the same time an induced current is generated in the secondary coil, which is taken off from the other commutator.

By suppressing the secondary coil the apparatus works as a motor pure and simple, and this is the arrangement employed by the inventors for driving their distribution commutators.

CUTTRISS'S IMPROVED SIPHON RECORDER FOR SUBMARINE CABLES.

One of the most interesting exhibits at the American Institute Electrical Exhibition is a cable recorder designed by Mr. Charles Cuttriss. The following description of the instrument is taken from the *Electrical World* of New York :—

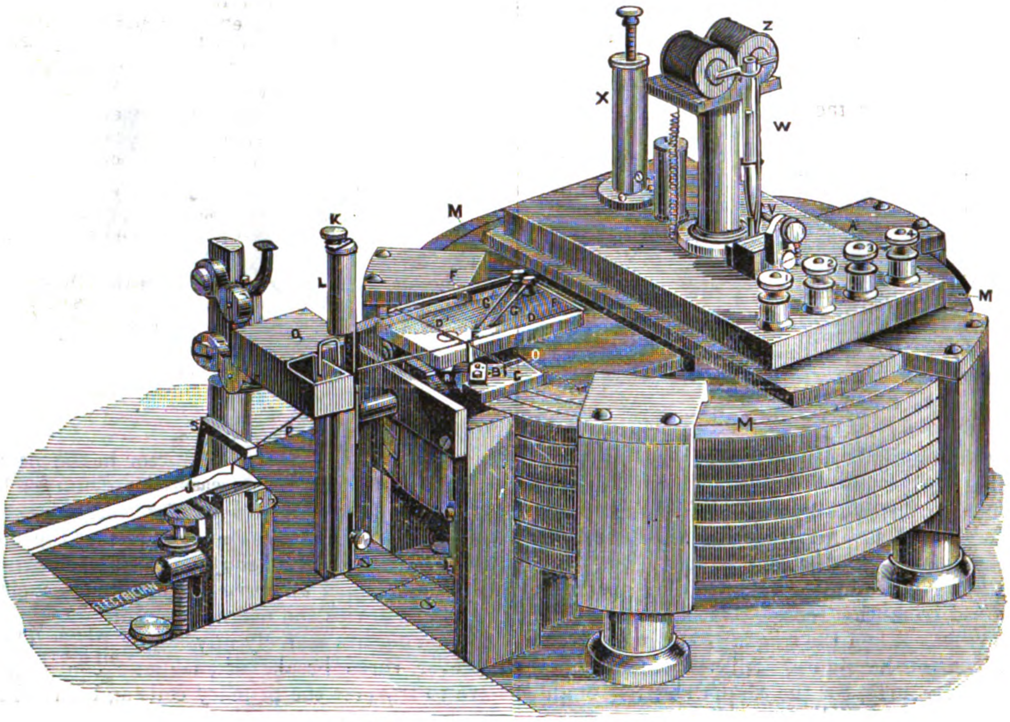
The improvement in this instrument over the older forms consists in the adaptation of magnetism in place of static electricity as a means of maintaining the vertical vibration of the siphon. This vibration is necessary in order that there may be no friction between the marking point of the siphon and the paper slip on which the signals are recorded. The instrument is also more easily adjusted than the older forms, all the adjustments being clearly in view of the operator, so that any desired change can be made in the signals without interruption to traffic. The arrangement is such that, if necessary, the signal coil can be removed and replaced in a few seconds without changing or loosening the fibres or disturbing any other part of the instrument; or the magnets can be removed and replaced without disturbance to the signal coil or its attachments.

The paper slip on which the record is written is drawn at a regular speed under the point of the siphon by a small electric motor placed to the left of the recorder at a distance of about two feet from the siphon. By this arrangement the operator does not touch the slip, but reads and transcribes the signals as they pass under his eye, and he is generally writing the same word that the sender at the distant station is transmitting, instead of being three or four words behind, as is the case with the older forms of recorders, owing to the paper being hidden for some length behind wheel work. This alone effects a great saving of time in the reception of short messages.

The motor has been specially designed to run with six or eight gravity cells, as it has been found that not only are they cheaper to maintain, but they require much less attention than any other kind, and are more easily duplicated.

Our engraving shows clearly the functions of the different parts of the apparatus, of which we will first refer to that part of the instrument appertaining to the vibration of the siphon, and which insures a perfect record regardless of the state of the weather or the humidity of the atmosphere.

The siphon P is a fine glass tube about one hundredth of an inch in diameter, one end of which writes upon the paper slip J, and has attached to its point a piece of No. 30 iron wire about one-eighth of an inch long, which serves as an armature, and is controlled by the impulses of the magnetic table T, over which the paper slip passes. The impulses of the magnetic table are controlled by the vibrator, which is placed on the large permanent magnets M M, and consists of a glass tube W, which is connected by a tube of india rubber to the mercury reservoir X. The glass tube is supported by a steel rod carrying a spring contact point V, and carries an armature, seen opposite the poles of the small electro-magnet Z. When a battery of three or four gravity cells is connected to the terminals 1 and 4, the glass tube commences to vibrate at a rate determined by the height of the column of mercury in the glass tube W, the height of which can be regulated by turning the milled thumbscrew at the top of the mercury reservoir which connects with a plunger within the latter.



Cuttriss's Improved Siphon Recorder.

From the terminals 2 and 3 two wires connect to the electro-magnet of the magnetic table T. Thus, every time the contacts at V are closed the table is energised and the siphon is drawn down to the face of the paper by the attraction of the magnetic table for the small piece of iron which is attached to the point of the siphon. If the impulses given to the

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siphon are in accordance with its natural rate of vibration a succession of fine dots of ink will be left on the paper in a perfectly straight line, so long as the siphon is not moved laterally by the coil R and a supply of ink is maintained in the inkpot Q. Should the impulses given to the siphon by the vibrator not be in accordance with the natural rate of vibration of the siphon it will not vibrate and the record will fail. But by manipulating the plunger in the tube X the height of the column of mercury W is varied so that the rate of the impulses can be varied anywhere between 60 and 100 per second. Hence any siphon that would be suitable for the instrument can be controlled, as its rate will lie within these limits. When the proper height of the mercury has been once determined, which is generally found in less than half a minute, the siphon will continue to vibrate until it is broken or removed for other causes.

The signal coil R, which is moved by the currents transmitted from the distant station, is pivoted at the bottom and top B in agate bearings, and is free to move in the annular space between the poles of the permanent magnet M. On the top of the coil there is attached an aluminum extension, E, which has a narrow slot at its upper end through which passes the regulating fibre D′, one end of which is attached to a rigid support O, the other end being fastened to a flexible spring F. The strain on this spring and this fibre is regulated by moving the index G′, and the strain thus produced controls the movements of the signal coil R. Close to the point E and at right angles to the fibre L′ there is another fibre D, one end of which is attached to another exceedingly delicate spring F, the other end of which is fastened to an extension from a fine brass wire contained in the tube L, to which the siphon is secured. The upper end of this strained wire is attached to the thumbscrew K, so that by turning the latter the siphon can be moved laterally over the face of the paper to any required position.

Thus it will be seen that if the siphon is moved off the paper slip towards the front of the instrument when the fibre D is strained by moving the spring F outwardly, the siphon can be pulled by it into a position over the centre of the paper; the torsion on the strained wire and the strain on the spring now balance each other, and if the two cross fibres are fastened together at a point as near as possible to the extension E, any movement of the coil will be multiplied and transmitted by means of the fibre D to the siphon. By lifting the fibres out of the slot E and turning the coil toward the front of the instrument the coil and part of the pole-piece C can be removed from the instrument without disturbing any other part, and when replaced no readjustment will be necessary.

THE GOVERNMENT AND THE CHANNEL CABLES.

The *Central News* states that the Government have resolved to keep under their direct control all telegraphic cables between Great Britain and France, Holland, Belgium, and Germany as soon as the present concessions have expired. As far as Holland, Belgium, and Germany are concerned there has been no difficulty. Those countries were ready to readjust their telegraphic arrangements with England, and contracts have already been signed between Great Britain and the Dutch, Belgian, and German Governments, which will, when the present concession expires, place in the hands of the Post Office a monopoly of telegraphic communication. The Post Office authorities have already practically decided to lay additional cables from the East Coast to Rotterdam and Amsterdam, and thus, while a greatly accelerated service will be assured, it is probable that rates will be reduced, provided the International Telegraphic Union consents thereto.

A difficulty, however, has arisen in respect to France, which, after prolonged negotiations, consented to renew the concession to the Submarine Telegraph Company for a further period of fifteen years; but the Postmaster-General vetoed the arrangement, and declined to be any party to the renewal, pointing out that as the Government had agreed to work with Germany, Holland, and Belgium, they could not consent to an independent company dealing with messages from and to France. Moreover, as the British Post Office has a monopoly of all telegraph wires in this country, it would prevent the agreement referred to from being carried out. The authorities, however, were quite willing to buy the cables and plant of the Submarine Company at an electrician's valuation, but they would give nothing for the "goodwill." Against this decision the Submarine Company appealed to the Treasury, and some pressure was brought to bear upon the Government to allow the French cables to remain under the company's management. The French Postmaster-General personally came to London, and is still here. On Wednesday last Sir Julian Goldsmid, the Chairman of the Submarine Company, had a long interview on the subject with Mr. Goschen. The Chancellor of the Exchequer, however, could hold out no hopes of overriding the decision of the Post Office authorities, and little doubt is entertained that the Treasury will grant the necessary funds which will enable the Post Office to accomplish the work. This resolution on the part of the Post Office will, it is anticipated, not only tend towards a vastly improved and probably cheaper telegraphic communication with the Continent, but will also prove to be a profitable undertaking for the Government, as the earnings of the Submarine Company have always enabled them to pay a large dividend. The Post Office is prepared to employ the latest and most approved fast-speed instruments and all modern appliances to ensure the most rapid telegraphic communication between this country and the Continent.

A later report from the same source states that at Tuesday's Cabinet Council the Government finally decided to reject the petition of the Submarine Telegraph Company, and to continue the negotiations with the French Government for direct control over the telegraphic communications between the two countries by their respective Governments.

NOTE ON THE INSULATION OF ELECTRIC LIGHT CONDUCTORS.

M. R. V. Picou, writing in *L'Electricien*, expresses the opinion —in which most of our readers will concur—that the time has arrived when a serious effort should be made to obtain somewhat more definite views as to what ought fairly to be required for the insulation resistance of electric light conductors. M. Picou usefully points out that whatever may be the system of distribution, whether series or parallel, and whatever may be the potential at the terminals of the machine, it is, or should be, possible to express the requisite total insulation resistance in the form

$$R = K r,$$

where R is the insulation resistance, r the copper resistance, and K a constant, which is the one thing we have as yet but scanty knowledge of.

The above expression may be justified by the following considerations :—It will be admitted (though possibly not by every one) that the insulation should increase with and be proportionate to the difference of potential adopted. The *total* insulation resistance must also be inversely proportionate to the total length of the conductors. If the distribution is in series with constant current, then the second condition is included in the first—that is to say, the potential will necessarily increase with the length of the line. If, on the other hand, the distribution is parallel, then the maximum current is a measure of the extent of the circuit. In either case we may therefore write

$$R = K \frac{E}{C} = K r.$$

M. Picou's reasoning is obviously only approximate, for he is obliged to assume that the length of the line is proportionate to the number of "translating devices" which it contains. Nevertheless, on the principle of half a loaf being better than no bread, the expression may be expected to be of some practical assistance.

It remains, however, to get a value for the constant K. Should it be 100, 1,000, or 10,000? For an answer we can only appeal to those who have the means of making measurements of actual installations under various conditions. If some few electricians would devote their spare time to taking measurements of the insulation and copper resistance of all kinds of electric light installations, with careful notes as to the general condition and behaviour of the installation, our knowledge of the coefficient in question would soon be improved.

Errata.—We regret that through an oversight the proof of Prof. Barrett's paper on Manganese Steel, given in our last number, was not sent to the author before publication, and accordingly a few clerical and printer's errors appeared in it; *e.g.*, on p. 545, middle of left-hand column, "intensity nearly eighteen, &c.," should be "elongation nearly, &c." Top of the same page and column (third line) "with the maximum load there was no set," the words "*with the hard wire*" should be inserted; ninth line from bottom of the same column "its increase for temperature," the words "increase for" should be omitted; in the first line of the last paragraph but one from the end of the paper, "more magnetic metal" should be "non-magnetic metal."

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VOLUME XIX.

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INDEX TO VOLUME XIX.—With our last number was issued as a supplement (Gratis) the Index to Volume XIX. This Supplement should have been received with every copy of the Paper. Complaints of non-receipt should be at once forwarded to the Publisher.

SPECIAL NOTICE.

All correspondence and contributions intended for this Journal should be in future addressed to THE ELECTRICIAN, 1, Salisbury-court, Fleet-street, E.C., instead of to Mr. C. H. W. Biggs, whose connection with the establishment has ceased. We deem it right to add that no other change whatever has occurred or is contemplated in the proprietorship or management of this Journal.

THE ELECTRIC LIGHT AND TRAMWAY AT BLACKPOOL.

The Mayoral banquet given at Blackpool last Friday week was a fitting celebration of a very notable enterprise which reflects the greatest credit on the Corporation and people of that town. It was at Blackpool that one of the earliest attempts at outdoor electric lighting was undertaken, and the lamps erected on the Promenade by Messrs. SIEMENS eight years ago are the same that illuminate it now. Dr. COCKER, the then Mayor, was mainly instrumental in causing the experiment to be tried, and as present Mayor he has commemorated its success in a manner which commends itself best to the civic mind and body. But Blackpool is also noteworthy for one of the most successful applications of electricity to the purposes of locomotion, and at present the solitary example of the "conduit" system in this country. Mr. HOLROYD SMITH's electric tramcar system is perhaps the best known of its kind; and besides being a fairly gratifying success to the promoters it has given great satisfaction to the townspeople. The double event, so to speak, was therefore

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celebrated with considerable *éclat*; and to import an appropriate tone to the gathering the presence of a number of guests connected with electrical science and industry was duly secured. We are not prepared to say that the electric railroad at Blackpool is "one of the marvels of the universe," or that the fame of "our system of lighting" has extended to the remote Antipodes. On the other hand, we are not in a position to deny that some useful practical work of a pioneer kind has been done at Blackpool; and we are well content that the inhabitants of this interesting watering place should indulge a feeling of pride in their electric tramway. For without the encouragement and assistance given to it by the local authorities, the scheme could hardy have prospered as it really has.

Although it has escaped those disastrous inroads of the sea which on at least two occasions have swept away its prototype at Brighton, the Blackpool electric railroad has had many difficulties to surmount, many mistakes to rectify, and many accidents to make good. If self-help were not a fundamental doctrine in scientific as well as in commercial life with all Englishmen we should almost be disposed to ask for a public grant to cover the losses incurred by experiments of this kind. It is impossible to foresee and guard against every obstacle that may arise in giving practical expression to a promising idea; yet, unless these risks are incurred, the idea can never be realised, and the world is that much the poorer in consequence. As a rule, the first attempts at realisation are failures, and those who direct them are not the people who reap the reward. All the more, therefore, is a debt of gratitude due to the pioneers of electric locomotion, which, like steam locomotion in its earlier development, has so many mechanical and financial difficulties to encounter, that no amount of success to be reasonably anticipated for some years to come can relieve us of our obligations. One of the speakers at the banquet, speaking in enthusiastic terms of Mr. HOLROYD SMITH'S achievement as "a feat which would not be forgotten," added "Blackpool would figure prominently in the history of electricity when it came to be written." That may be a pleasant outlook for Blackpool; but for the men who risk their money and reputation on novel and untried enterprises the prospect is not so satisfying and the tangible result not so alluring.

Nevertheless, the promoters of electric locomotion have succeeded far beyond what is customary in such ventures; and the one at Blackpool affords promise of a not very distant future which may recompense them for all the disappointments and struggles they have had to brave. From November 1st, 1885, to the end of October in the following year the electric tramcars at that place ran 70,492 miles, carrying 636,252 passengers. With the exception of a six days' stoppage, through frost and sand, last winter, the railway ran continuously till Whit-week of the present year, when a serious obstacle arose, in consequence of the continuous hot weather, which expanded the copper tubes, so as to drag the iron stud of the insulator, which had corroded and got loose by the action of the salt water. Notwithstanding the delay caused by these unforeseen accidents, the number of passengers carried during the year just ended has been nearly as great as in the preceding year; and at the present moment the line is working as well as can be wished, the machinery and general arrangements being now in a better condition than they ever were. It would be rash for even a native of Blackpool to assert that the whole problem of electric railroads has been solved by this very admirable experiment; but it certainly affords much ground for confidence in the future prospects of that mode of locomotion. It was but natural under the circumstances that a good deal of tall talk should be indulged in, and visions of electric motors supplanting the steam locomotive and running with double express speed at half the present cost. But for the present we are more disposed to follow the speaker in his reference to the superiority of electricity for the underground railways of the metropolis—a superiority which we have reason to believe may yet be demonstrated at an earlier date than most people imagine.

THE PROPOSED ASSOCIATION OF ELECTRICAL ENGINEERS.

The following circular has been addressed from this office to the Electrical Engineering firms throughout the country:—

DEAR SIRS: With reference to the present discussion on the advisability of forming an association to deal with the commercial aspect of electrical engineering, it has been suggested that the editors of this journal should take the initiative in arranging for a meeting of the trade. Before undertaking this responsibility, and solely in order that a public discussion of the question may lead to some definite result, for or against the proposal, we have thought it desirable to submit to you certain suggestions which have been made, in the form of a series of resolutions, for consideration at the proposed meeting.

It will, we trust, be understood that in taking this course our object is to facilitate discussion, and not to direct the organisation of the movement—a duty which must rest entirely with yourselves, or with such Organising Committee as you may appoint.

May we therefore trouble you to return the annexed sheet, signifying thereon your assent to or dissent from the Resolutions proposed, and to add such suggestions or modifications as you may prefer? As soon as these replies have been received the results will be published in *The Electrician*, and should they be of such a character as to justify further action, you will then be invited to attend a public meeting.

Faithfully yours,

THE EDITORS OF "THE ELECTRICIAN."

RESOLUTIONS.

I.—That this meeting recognises the desirability of forming an Association for the discussion of matters relating to the Electrical Industries, and for securing the united action of the representatives of those Industries where their commercial interests are in general concerned.

II.—This meeting further recognises that the existing SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS is entirely capable of fulfilling the scientific requirements of the Electrical Industries, and that the proposed Association should supplement without superseding in any degree this or any other existing Institution.

III.—That an Organising Committee of twelve members (with power to add to their number) be now nominated from the body of this meeting.

IV.—That it be an instruction to the Committee to consider the details of the scheme, and in particular to report on the following points:—

(1) The practicability of working the Association on the basis of holding two half-yearly meetings, each (say) of three days' duration.

(2) On the conditions of membership.

(3) On the financial aspects of the scheme.

We shall be glad to send this circular to any firms who, through inadvertence or the incompleteness of our lists, may not have received a copy.

We select the following letters for publication this week as representing more exactly the views which we ourselves have entertained on the subject from the very first:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Judging from the correspondence and from some other printings on this subject, it appears that the real objects of the Association are being misunderstood. I do not know that I am right, but I was certainly under the impression (1) that

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as electrical developments have increased so enormously in the past few years; (2) that as electrical applications have in so many ways called for the combined skill of the electrician and mechanical engineer; (3) that as electrical engineers are practising in a comparatively new field and on an untrodden path of engineering enterprise; (4) that as electrical manufacturers are working for and establishing a new industry; (5) that as these manufacturers have to work to a great extent to suit the electrical engineers, and the latter in accordance with manufacturers' exigencies, and as both electrical engineers and manufacturers have to work in connection with steam and other engine builders; and (6) that as there are so many questions upon which these several sets of men could, for these several reasons, meet with advantage to compare notes, discuss practical problems that turn up from time to time, questions of policy, and subjects requiring concerted action, an Association of Electrical Engineers was deemed necessary. It is well known that there are many busy men who have not the time to spare to sit down to write systematic papers on questions in electrical engineering practice or enterprise, but who could, at the meetings of a suitably organised association, present such subjects in the remarks of a few minutes.

The experience of the more active part of the life of the Dynamicables showed that very useful debates on practical questions could be obtained in this way, the proposed subject of debate and the name of the proposer and propounder being given in the programme sent out announcing the meeting. Most of the members of the Dynamicables are members of the Society of Telegraph-Engineers or the Civil or the Mechanical Engineers; but none thought that the Dynamicables were Trades Unionists on the one hand, or met to conspire against these older societies on the other. The questions that do and will crop up on electrical engineering matters are so very numerous that more than one existing society will have to double the number of its meetings, extend the scope of its discussions, and relax some rules concerning papers to be discussed if they intend to avoid the necessity for a special society. The purely trade notions which have been disseminated concerning the proposed society are, I assume, mistakes, and that the real object is to form a society for the advancement of electrical engineering and manufactures, and generally for the advancement of the interests of those engaged in the practical applications of electricity.

London. W. W. B.

SIR: The idea to form an Electrical Association in England has taken its origin from the fact that something of this kind exists in America, and may therefore be found very useful in this country.

Allow me to say that the American Association is based on a state of matters totally different from that existing here. The men who are interested in the various central stations located in almost every city of the United States felt a desire to meet twice a year for the purpose of exchanging their views and experiences. These meetings are at the same time visited by manufacturers, who avail themselves of the opportunity to demonstrate and exhibit new devices for the purpose of supplying electric light and power from central stations. The various Edison companies are not members of this association, but hold their meetings separately.

What is wanted in England is something entirely different. Electric light stations hardly exist, but the electric light business meets with difficulties which are quite peculiar to this country. An association formed for the tangible purpose of dealing with these difficulties would undoubtedly have the hearty support of all members of the profession, and of all those interested in the use of electric light and power.

We do not require another discussing society such as the Society of Telegraph-Engineers and Electricians, nor an electric light police which has to watch over the prices charged by different contractors; but an association formed for the purpose of accomplishing the first three objects mentioned in Mr. Rawson's letter, excluding the other fourteen, would probably find general support.

If after a series of years this "Electric Light and Power Association" has fulfilled its object it may well go to rest with the feeling of having done something useful, or it may later on extend its objects in order to meet the wants of some future time.—Yours, &c., ALEXANDER BERNSTEIN.

REVIEWS.

Handbuch der Elektricitat und des Magnetismus. By Dr. O. FRÖLICH. (Berlin: Julius Springer.)

This handbook of electricity and magnetism is a second edition of a work published under a different title nine years ago, and is intended to bring the original work up to date. With this object considerable additions have been made to the first edition, which was a handbook of telegraphy; but the result is not altogether satisfactory. The portion of the present work treating of telegraphy is good. The author has evidently considerable experience in this particular branch of applied electricity, and he has succeeded in explaining the somewhat complicated phenomena occurring in long submarine cables with great clearness, and, as far as could be done with the exclusion of mathematics, even with scientific accuracy. But if we turn to the remaining portion of the book—which is professedly written as a guide for electricians engaged in the construction and use of dynamo electric machinery and telephonic apparatus—we cannot pass such a favourable verdict; in fact, it is difficult to see what class of readers is to derive practical advantage from this book. In form it resembles somewhat an ordinary elementary science text book, but without rigorous scientific treatment, whilst its substance—in these days of rapid development in all branches of applied electricity—is really very slender and stale fare. The practical electrician will not find in this book any information about the most modern dynamos, motors, lamps, &c., whilst the schoolboy, who might take the book up with the object of studying the science of electricity as taught by one occupying a high position in the profession, will find his study uselessly burdened with descriptions of the early dynamo machines made by Messrs. Siemens and Halske, of Berlin, the early arc lamp (by the way, the only arc lamp described in the book) made by Messrs. Siemens and Halske, of Berlin, the various and mostly antiquated alternate current dynamos made by the same eminent firm, and so on. The description of a few machines and instruments made by the firm with which the author is connected does not suffice to give the book a practical value, whilst the omission of all mathematical treatment beyond simple algebra, and especially the omission of the theory of the potential, seriously diminish its scientific value.

We have already said that the chapter treating of telegraphy is well written and will be useful to telegraph engineers. The author discusses at length the insulation resistance of long submarine cables; the counter electromotive force observed in a cable, which he considers as probably due to molecular strains in the insulator; the capacity of cables; the retardation and weakening of currents; the induction in overhead lines; the speed of propagation of electric waves in cables and wires, &c. The chapter dealing with electric measuring instruments and their application to the finding of faults in telegraph lines is also of value, but we regret that the author should in the main have restricted his descriptions to apparatus made by Messrs. Siemens. The reason for this restriction is stated in the preface, and as it is characteristic of the self-sufficiency of a certain school of modern German technical *savants*—of which class the author is by no means an isolated example—we make no apology for giving here a verbal translation of the passage:—"As regards measuring instruments, these described are almost exclusively made by Messrs. Siemens and Halske. I hope that this will be found but natural, since I have for a considerable time cultivated this branch of the firm's business, and since it cannot be considered one of the duties of an author to prefer the opinion of others to his own."

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THE DESMAZURES SECONDARY BATTERY.*

BY M. E. REYNIER.

The well-known zinc-potash-oxide-of-copper cell of MM. Lalande and Chaperon is excellent as a primary battery; but, although these inventors have made many attempts to regenerate the cell by electrolysis, their efforts have not led to industrial success.

A secondary battery of this description—that is to say, employing caustic alkali in lieu of acid—has, however, at length been produced by M. Desmazures, and has recently attracted some attention amongst electricians by its performance at Havre, where a battery weighing 4,400lb. propelled a launch weighing 11,000lb. during five hours at the average speed of 6·5 knots per hour, the output being at the rate of 12 horse-power, or a total of 60 horse-power hours.

The negative plates of this cell are made of tinned iron; the positives are plates of porous copper, obtained by compressing the pulverised metal under 600 to 1,200 atmospheres. The liquid is a solution of zinc in sodic hydrate, or a solution of potassic hydrate added to chlorate (?) of sodium. The cell is made of tinned iron; it is entirely closed in, and is connected with the negative plates.

During the process of charge metallic zinc is deposited, and is taken up in solution during discharge. The oxides of copper are not completely insoluble in the caustic alkalis. In order to avoid the solution of the oxides in the electrolyte, and their reduction upon the zinc, the positive plates are enclosed in bags of parchment-paper supported by vertical rods of glass, which also serve to insulate the plates. The following figures relate to a cell of type No. 4:—

Number of positive plates		5
,, negative ,,		6
Total weight of plates		13·2 lb.
Size of positive plates	height	0·25 in.
	breadth	0·25 ,,
	thickness	0·002,,
Size of negative plates	height	0·3 ,,
	breadth	0 25 ,,
Total weight of cell		44 lb.
E.M.F. on open circuit		1 volt
External E.M.F.		0·85 ,,
Charging current		18 amperes
Maximum discharging current		36 ,,
Capacity		372 amp. hours
Work done in discharge		0·42 h.-p. hour
Weight of plates per h.-p. hour		66 5 lb.
Total weight ,,		99·5 ,,
Weight of plates for h.-p. (output)		323·5 ,,
Total weight ,, ,,		1078·0 ,,

But the battery employed in the Havre experiments seems to have shown better results than these as regards weight. The battery of 132 cells weighed 4,400lbs. It gave during five hours a current of 87 to 89 amperes under a potential of 100 to 104 volts. We thus get:—

Total weight per H.-P. hour	72·6 lb.
Total weight for one H.-P. (output)	365·5 ,,

A considerable reduction of weight has thus been effected, but on the other hand the available E.M.F. has fallen to 0·78 volt per cell.

But the weight of 365·5lb. per horse-power is not remarkable; it had already been obtained—*upon the same boat*—by Reynier accumulators with corrugated plates, in November last year. But for ratio of work (horse-power hours) to weight, the Desmazures cell is superior to any Planté cell as yet in the field. It is also claimed that the cell has a very high coefficient of restitution. *A priori* it may be admitted that this will be the case as regards the ampere-hours, because the electrolysis of alkaline zincates is not accompanied by the evolution of gas, and yields deposit of zinc of very regular and very adherent character.

But, on the other hand, we have to remember the loss of E.M.F. In my own experiments I have found that while it takes an E.M.F. of at least 1·2 volt per cell to charge this type, we do not get more than about 0·65 volt in the discharge.

The duration of the negative plates will no doubt be very great in this cell, as in all others. As to the positives I am not so sure. The flakes of greenish blue are not reassuring; the parchment paper will certainly be attacked by the caustic alkalies. The inventor should amend this detail.

Comparison of the Caustic-Alkali Cell with the Planté type. Should the relative lightness of the caustic-alkali cell induce us to abandon the Planté type? What is the probable future of the two systems?

While waiting for an answer from practice we may interrogate theory, and we shall learn that *in principle* the Planté type is preferable to the other, *even in point of view of lightness.* Let us compare the weights required in the two systems for the same output, for example 3,600 kilogrammetres.

PLANTÉ TYPE.

Available Difference of Potential 1·8 Volt.

	Grammes.
Lead	42·21
Oxygen	3·26
Sulphuric Acid	20·00
Water	40
	105·47

CAUSTIC ALKALI TYPE.

Available Fall of Potential 0·8 Volt.

	Grammes.
Zinc	15·1
Cuprous oxide	18·3
Potassic hydrate	25·7
Water	77·1
	136·2

Theoretically, therefore, the Planté cell is lighter by 23 per cent.

The actually lightness of the Desmazures cell is due to a better utilisation of the essential elements. The excessive weight of the lead elements is above all due to the mass of inert metal which acts merely as a conducting support for the active material. If this dead weight could be suppressed or diminished it would make a surprising difference. I have myself obtained remarkable results in this direction, but to avoid introducing the personal element let me be content to refer to the plates of Mr. FitzGerald which are exclusively composed of lead peroxide, with a thin conducting plate of platinum. These cells are said to answer very well, and they give a horse-power-hour with a weight of less than 73lb.

It seems, then, not difficult to realise in practice the theoretical superiority of the Planté cell in the matter of weight. We ought also not to lose sight of the fact that the lead cells occupy much less space than the other type. This is frequently an important point.

In the matter of first cost it is necessary to remark that copper and potassic hydrate are more expensive than lead and sulphuric acid. In fact, in combining the figures for theoretical weight and cost of material for the same output, we find that the first cost would be about four times as great for the alkali as for the acid cell.

* From the *Moniteur Industriel*, November 3rd, 1887.

NOTE ON TRADE DISCOUNTS.

BY J. M. V. MONEY-KENT.

The writer feels that some apology is needed for this note, as the problem involved is of the easiest possible description; but yet, finding it to be an almost universal practice to employ a happy-go-lucky method for its solution, he ventures to give the following solution as being quite as easy as any haphazard method.

To find what percentage it is necessary to add to a given figure in order to allow a discount of a given amount:—

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Let x = the given figure,
X = the new amount,
λ = the percentage to be added,
μ = the discount.

Then we have

1. $$x\left(1+\frac{\lambda}{100}\right)=X$$

2. $$x = X\left(1-\frac{\mu}{100}\right)$$

The elimination of x, X is at once given by the determinant.

3. $$\begin{vmatrix} 1+\frac{\lambda}{100}, & 1 \\ 1, & 1-\frac{\mu}{100} \end{vmatrix}=0$$

the solution of which is

$$\lambda=\frac{100\,\mu}{100-\mu}.$$

By writing this in the form $\frac{\lambda}{100}=\frac{\mu}{100-\mu}$ a simple rule of thumb method is at once obtained, for $\frac{\lambda}{100}$ represents the fraction of x to be added. Thus, if the discount to be given be $\frac{a}{b}$, then the amount to be added will be $\frac{a}{b-a}$.

If we go one step further we may represent the whole thing by means of a curve, and such a curve traced out with ordinates and corresponding abscissæ marked and hung up would be very useful in the office as a reference table. Putting $x\ y$ for $\lambda\ \mu$ in equation 3, and expanding, we have

$$x\,y-100\,x+100\,y=0,$$

which is the equation of an equilateral hyperbola passing through the origin whose centre is given by the equations

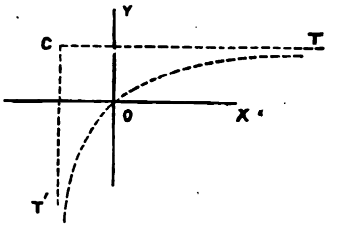
$$x+100=0$$
$$y-100=0.$$

Also $$\frac{dy}{dx}=\left(\frac{100}{x+100}\right)^2.$$

Hence $x+100=0$ is an asymptote; similarly $y-100=0$ is an asymptote, and the axes are given by

$$x^2-y^2+200\,(x+y)=0.$$

Thus the curve is easily traced, and is as follows:—



C is the centre of the curve; C T, C T', the asymptotes. Thus the ordinates represent the discount it is intended to allow, and the abscissæ the percentage to be added.

SPUR GEARING FOR ELECTRIC TRAMCARS.

Mr F. J. Sprague, whose electric motor system is well known in the United States, writes as follows to our contemporary, the New York *Electrical World*:—

At a meeting of the American Institute of Electrical Engineers, held September 20th, Mr. Anthony Reckenzaun, in an address on the subject of "Electric Street Cars, with Special Reference to Methods of Gearing," referred to the experiments which are going on at Mr. William Wharton, jun.'s establishment in Philadelphia, and makes the following statement:

There we used a set of spur gearing, which was supplied by the Sprague Company. In this case the motor shaft, which runs at from 500 to 600 revolutions a minute, carries two steel pinions, one at each end of the shaft, and these pinions gear direct into two cast iron spur wheels upon the driving axle without any intermediate wheels. The motor is partly suspended on the axle and partly on the body of the car. We have run several hundred miles with this car under all conditions of load, gradients, and weather, on some of the roughest tracks in Philadelphia, but up to this moment not a single hitch has occurred. The gear is perfectly noiseless, it is efficient and strong, and I see comparatively little indication of wear. The teeth are beautifully shaped, therefore somewhat expensive; but if they last long enough and if they do not rattle when partially worn, this expense can be ignored. This car contains, besides its usual weight, about 3,200 pounds of storage batteries. It has to mount grades of 5 per cent., and run on curves of 35 and 25 feet radius, which means very hard work.

I wish to correct an impression which one would gather from these remarks of Mr. Reckenzaun, and which hardly do justice to the method of mounting which is there used. The suggestion that the gears are necessarily expensive because of the beautiful shape of the teeth is incorrect; the shape of the teeth has absolutely nothing whatever to do with the expense of the gears as we make them, for they are no more expensive than any other form of tooth in cut gears.

There are several reasons other than the shape which make these gears so noiseless. The motor, in the first place, is hung upon the driving axle at two widely distant points, and is supported in the centre of the other side by a double compression spring. In this manner absolute parellelism is maintained between the driving and the driven axle in all planes, no matter what the movement of the axle. There is no twisting or tendency to twist on the face of the gears and pinions; the thrust at all times is absolutely in the plane of the gears and pinions, and these are always parallel. The bearings of the armature are very close to the pinions, so that there is no spring whatever in this shaft. One pinion is set about half a tooth ahead of the other. One of the main gears is fixed; the other is adjustable, so that there is no interference in the thrust of the pinions, and a much more perfect simultaneous meshing of the gear is obtained than would be possible where dependence upon the cutting of the splines is necessary for the adjustment.

From two to three teeth on each pinion are always engaged. The proportions of the pinions are such that the armature has to make as many revolutions as there are teeth in the large gear before the same teeth in the gears and pinions engage with each other, and, finally, by reason of the method of supporting, there is always a spring touch, so to speak, of the pinions upon the gears. No matter how sudden a strain is brought upon the motor, it always yields more or less in a direction concentric to the axle of the car, so as to relieve the teeth from all shock. The wear of the gears must be absolutely the same. It is simply impossible for rattling to take place on these gears even if they were worn down one-half of their present thickness, and this wear, where the gears are properly protected by screens, will be very light.

The method of mounting and the general plan of using these gears has far more to do with their noiselessness and efficient operation than the shape of the teeth, although this shape, being of the involute character, is such that they will mesh perfectly even where there is some change in the distance between the centres of the axles. If it were not for the method of mounting it would be impossible to run this kind of gearing, as has been frequently done, with variable strains at a speed as high as 1,200ft. per minute. At no time, under the severest strains it is possible to put on gears of this character, have they ever shown any signs of weakness or undue wear, and in comparison with fixed gear this method of mounting must necessarily be the more satisfactory.

BANQUET TO ELECTRICIANS AT BLACKPOOL.

We briefly referred in our last issue to the banquet given by the Mayor of Blackpool in connection with the electric traction and arc lighting carried out in that town. The speeches of Mr. Alexander Siemens, Mr. Parker, Mr. Broadbent (of the Tramway Company), and Mr. Chew (the engineer to the Blackpool Corporation), which we print below, will be read with interest:—

Mr. Parker, of Wolverhampton, in responding to the toast, said that electricity as used for locomotion had a very short history, and most of them would be acquainted with it as applied in this respect. Many would remember seeing at the Paris Exhibition of 1881 perhaps the first tramway of any importance that had been publicly exhibited. Many of them would have visited the tramway at Portrush, in the north of Ireland, one of the first and still perhaps the longest in use in this country run by electricity. They at Blackpool followed, and perhaps succeeded in doing a greater work, which it would not have been to their credit if they had not done. He was glad to hear strangers speak well of the enterprise, because the Blackpool tramway was now old—two years in the history of electrical development was a long period of time. When they looked and saw what had been done on the Blackpool tramway, and considered what could be done they thought that this enterprise was but a small dwarf as to what was possible and practicable. He remembered that when they first tested the motors now driving these trams they found they could get 7 horse-power with about 16 hundredweight in the motor. They could to-day easily obtain 25 horse-power from the same weight, and at the same time attain a higher state of efficiency. They could now at half the cost produce better machines than the dynamos now used for the Black-

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pool tramway. He did not say this to discourage the Blackpool people, but he felt bound to give exactly the circumstances as far as he conceived them. They had got on to a period of further development and application of electricity, and could to day drive electrical tramcars by storage For a long time the gearing of tramcars stood in their way, but the gearing had been simplified and rendered more practical and controllable in the driving of cars. He had taken a contract to put a motor on the tramway at Wolverhampton which would enable the cars to run by storage up a gradient of 1 in 18, and to run a length of 7 miles and carry 50 passengers. There was at present an agitation with regard to underground railways. Electricity was extremely well suited for driving underground trains. With electricity they could get rid of the nuisance of smoke and noxious vapours in underground carriages. He considered from past experience that no limit seemed possible to the application of electricity as a driving power, and almost whatever was asked of the firm of which he was a representative they were prepared to carry out. He believed that by electricity a train might be run from London to Edinburgh at a speed of 70 miles an hour cheaper than by steam. He was not in the habit of prophesying, but he spoke only from facts, and believed the time had arrived when almost anything desirable could be achieved by electricity in its application to railways [applause].

Mr. BROADBENT said he was much disappointed with the speech of Mr. Parker, the gentleman who supplied their machinery, for he now told them that he could supply it at half the price [laughter]. As to Mr. Parker's confidence in accumulators, he could not yet share that confidence. Accumulators were at present on paper, and paper would not pay dividends. As they were aware, a little over two years ago the Mayor of Manchester (Alderman Harwood) did Blackpool the bonour of inaugurating its electric tramway. He drove the first car, and afterwards spoke confidently of the line's future success, and at the banquet which followed, Mr. Holroyd Smith, the patentee of the centre channel, explained the theory of its working. However, the few remarks he (Mr. Broadbent) had to make were on the results. For over two years they had had many difficulties to contend with. They found that the motors for the cars were not quite equal to the strain put upon them; but, by the kind assistance of Mr. Parker, the maker of the machines, these had been very much improved. The collectors also gave much trouble, mainly through the shallowness of the channel, but by experience they had been able to overcome this difficulty to a very great extent. Had the centre channel been made deeper many of the troubles would have been avoided, and the expense of cleaning the channel very much reduced. In his opinion, if their system of tramway were laid where there were not the difficulties of sand and sea-water to contend with, and constructed with a deeper channel, it would prove a great success. From November 1st, 1885, to October 31st, 1886, they ran 70,492 miles and carried 636,252 passengers. The cars were stopped for five or six days, the stoppage being caused by frost and sand. The working continued very satisfactorily until shortly after Whit-week in the present year. Then the continuous hot weather caused the copper tubes or current conductors to expand so much as to drag the iron stud of the insulator, which had corroded through the contact with salt water, until it had become loosened. This caused a leakage and the insulator to crack. They expected to overcome this difficulty as they had overcome many others, as they had got a new insulator on an improved principle that they thought would be effective. This accident had caused a serious loss to the company which could not be avoided. However, he did not expect such a misfortune to happen again. Notwithstanding this stoppage they ran between November 1st, 1886, and October 28th, 1887, 72,875 miles, and carried 619,500 passengers. At the present time the working was as well as could be wished and the machinery in excellent condition. They were able to carry six times the amount of passengers they could get in the winter months without additional cost to the Company. Many people had said that they should never succeed, but he thought the figures he had quoted would prove that they had run fairly well, and augured well for the future.

Mr. SIEMENS paid a cordial compliment to the enterprise shown by Blackpool people. He thought, with Dr. Kingsbury, that electric lighting should be extended to the houses. This was the second time he had visited their town, his first visit being on the occasion of the introduction of the electric light, eight years ago. He was glad to see that the lamps which were then arranged, and which had been since that time under the good care of Mr. Chew, did not compare badly with some of the more modern lamps [applause]. It would be difficult to appreciate the public spirit shown at that time by Blackpool, because we progressed now so quickly that one was apt to forget the position of affairs in 1879. The electric light had just been talked about, but nobody appeared to know anything about it. Their present mayor came up to London to see him, and said they wanted their Promenade, the distance of which he believed was 2,700 yards, lighted by electricity. Such lighting had not been done at that time, and his firm would never have had the opportunity of carrying out such lighting had it not been for the public spirit and enterprise shown by Blackpool. That the system which they adopted succeeded was due to Sir William Siemens, whose loss they all deplored [hear, hear]. Its success also was very creditable to Mr. Chew, who had managed the undertaking exceedingly well from a financial and also from an electrician's point of view. Blackpool, he thought ought to feel proud with such an enterprising Corporation and such a skilful engineer [applause].

Mr. CHEW said that power to carry out the Blackpool line was obtained from Parliament in 1879, a clause being inserted in the Improvements Bill by which they were enabled to supply electricity for public purposes. These clauses were put into most of the Acts obtained about then by the Parliamentary agents. So far as the Blackpool Corporation was concerned, an additional clause was put in that gave power to borrow £5,000 to be used for electrical purposes. This was only obtained on condition that the whole was to be repaid in ten years. This clause was a very heavy burden upon the past and present ratepayer. Nevertheless, three-fourths of the sum had been paid, and the balance would be paid off in 1890, after which the apparatus at present in use would be the clear property of the ratepayers without further charge, except for wear and tear. The present mayor, who was also mayor at that time, had determined, in conjunction with the Council, to make a forward step, and, if possible, to add to the attractions of the three miles of Promenade by lighting that part situated between the two piers, and also at the pierheads, with the most powerful of the then-known arc lamps. He need not say with what result, as that was known to them all. They now possessed the best display at night on the Promenade in the visiting season that could be found in England. The area between the piers had 54,000 candle-power of arc lights, the other portions of the Promenade having double-burner gas lamps—one at every twenty-five yards—covering the whole distance. These arc lights were a great convenience to the numerous pleasure steamboats that sailed between there and the Isle of Man, Llandudno, Wales and the Lake District. The lights could be seen out at sea from the packets for fully fourteen miles. In the earlier period they had considerable difficulty in dealing with the electric force. Leakage, as every electrician knew, was the bugbear constantly to be contended with; expansion and contraction of the wires, faulty packing and insulation, delicacy of the machines and instruments, rendered constant and skilled supervision necessary. But experience had been gained, and that counted for something in the general result They had seen that night some of, if not the very best arc lamps at present in use. It might be interesting to show what had been the cost, both on capital and maintenance account, and for that reason he had taken out the items of the maintenance account for the last five years and classed them under different heads. To begin with, the capital expended was £3,600—for machines, wires, engines, boilers, lamps, posts, sheds, and cost of erection. The interest of this, at 5 per cent., is £180 per annum, and for the five years would be £900. They used the lamps only 1,000 hours each year, or, for the five years, a total of 5 000 hours. That worked out to be 3s. 9d. per hour for capital charges at the above rate of interest, but, of course, they paid considerably more in consequence of having to repay the principal in ten years; yet they had been maintaining the plant for the last eight years in first-class order, nearly all the wires and posts having been renewed and the wire put underground. The boiler tubes had been renewed, the whole plant being in some respects improved, in other respects remaining as good as at first. For the wear and tear for the five years—representing 5,000 hours of work—the account was as follows:—

	£	s.	d.
Fuel, water, gas, oil, &c.	£473	19	4
Carbons	389	4	2
Wages and salaries	845	10	11
Repairs and renewals (including wire)	863	19	3
Rent of ground	45	0	0
Rates and taxes	69	5	5
Boiler insurances	15	15	0
Carriage and sundries	42	10	9
Experiments	21	14	8
Total	£2,767	19	6

That worked out to 11s. 1d. per hour, which added to the 3s. 9d. made a total of 14s. per hour for a light nominally of 54,000 candle-power, and he knew from practical tests that these lights did give an average of from 4,000 to 6,000 candle-power each for the nine lamps in use [applause].

CORRESPONDENCE.

PRIMARY BATTERIES FOR HOUSE LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the discussion which followed the reading of Mr. Perry Nursey's extremely interesting paper "On Primary Batteries" before the Society of Engineers last Monday, we were favoured with the usual professional comparison between the cost of coal and that of zinc, with the seemingly inevitable inference, inseparable from such discussions, of—"*Ergo*, primary batteries cannot possibly compete with dynamos and steam engines." A few figures will, however, suffice to prove that such an inference is quite erroneous.

1st. When burning coal, even at the low rate of 4lb. per horse-power per hour, a steam engine is only utilising less than one-sixteenth part the theoretical heating power of the coal, for 1 horse-power (as defined by Watt) is equal to 33,000 foot-pounds per minute; whereas the theoretical power of 1lb. of coal is 10,500 (heat units) × 772 (Joule's equivalent) = 8,106,000 foot-pounds, and $\frac{4 \times 8106000}{60 \times 33000} = 16{\cdot}37$, a formula which to most of your readers will be perfectly familiar.

2nd. At 17s. per ton, one penny will purchase rather more than 18lb. of coal, so that the value of the 4lb. of coal is $\frac{2}{9}$ths of one penny. How is it that the theorisers do not go a step further and explain that their comparison of the cost of primary batteries with dynamos worked by steam or gas and accumulators would only hold good if the entire cost of that combination were represented by this $\frac{2}{9}$ths of one penny per

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hour, or, say, twopence for the average lighting day of five hours? The wages of one mechanic to attend to the engine and dynamo, keep in order and renew the brushes, &c., amount alone in small installations to more than the whole cost involved in the use of a primary battery; moreover, one horse-power per hour produced from a steam engine does not supply anything approaching one electrical horse-power of 746 watts. At the South Kensington Exhibitions the engines practically supplied on the average less than half that quantity of electricity in the lamps. The same is produced from one pound of zinc, costing 2d., working noiselessly, steadily, and without any attention in a primary battery.

3rd. With regard to gas, one ton of coal makes 10,000 cubic feet, and at 3s. per 1,000 cubic feet, costs the consumer 30s. Then, 4lb. of coal, converted into gas, produce eighteen cubic feet, which, with gas of 15 candle-power, will give light equal to fifty-four candles when burnt in the "London Referee" Argand burner. The ton of zinc costs eleven times as much as 30s.; but, on the other hand, 4lb. of zinc in a primary battery supplies 1,490 watts (two horse-power), or sufficient electrical power for twenty-four lamps of 20 candle-power (each of 62 watts), or 480 candles, and, weight for weight, nearly nine times as much light as that obtained from 4lb. of coal converted into gas and burnt under the most favourable conditions.

These figures, which any of your readers are quite competent to check, conclusively disprove the *à priori* contention that the question of the applicability of primary batteries to house-lighting is disposed of by the comparative cost of zinc and coal. Questions of mechanical detail, compactness of form, quantity and constancy of current, and, above all, the reduction of trouble to domestic servants, by simple arrangements of manipulation, are points of more importance; but, judging from my own experience, none of them appear to be such as need stand in the way of the future employment of primary batteries as the solution of the question of house-lighting by electricity.—Yours, &c., O. C. D. ROSS, M.Inst.C.E.

15, Relf-road, East Dulwich.

THE PURCHASE OF THE EDINBURGH GASWORKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I send you a copy of a letter which I wrote to the *Scotsman* – but which the editor would not publish—upon the proposed purchase of the gasworks by the town, which the *Scotsman* is desirous should be effected immediately. I also send you extracts of other letters against the scheme which they have seen their way to insert, and which of course they had no difficulty in replying to.

As this is typical of the vested interests against which electric lighting has to combat, as well as an example of the method adopted of upholding the same, it may afford interest to you and your readers.

The town authorities propose to pay the shareholders of the gasworks a 10 per cent. annuity on the value of shares, for the purchase—that is, equivalent to a capital sum of over £600,000 for what they might get for considerably less in ten or twenty years' time.—Yours, &c., W. GEIPEL.

6, York-place, Edinburgh, November 8th, 1887.

[COPY.]

To the Editor of the "Scotsman."

SIR: It may be of interest to your numerous readers to hear that during the few years I have been resident in Edinburgh, representing a well-known electric light company, we alone have either put to work or in course of erection a considerable number of isolated electric light installations, and from a knowledge of the amount of gas previously consumed in the various establishments, I find the total yearly consumption of gas superseded by electricity to be approximately equivalent to a revenue of £1,500. I see no reason why this progress should not be continued. Setting aside future inventions, it is my opinion that electricity, unfettered as it now is by such an Act as the Electric Lighting Act of 1882, is even now a not insignificant competitor of gas, not only for the illumination of our theatres, railway stations, works, and factories, but also in the homes of the more wealthy inhabitants. and in better-class shops, &c., while, for the supply of power to small users, such as printers, small workshops, and the like, electricity has, in Continental towns, wherever it can be had from the street mains to drive motors, proved itself in every way better fitted than gas engines. In the United States there is hardly a town of 20,000 inhabitants and upwards which has not a central station for the supply of electricity, and many also of from three to four thousand inhabitants are lighted with electricity. One firm alone has supplied over five thousand electric motors for driving various machinery. . . . It is without doubt a good thing that the town should become proprietors of its gasworks. I take it we are nearly all agreed upon that point. The question is, What is the value of the goodwill? Are we not paying too high a price? When gas was first introduced for public lighting in the beginning of this century, speaking from memory it cost above four times what it is being supplied for in Edinburgh at the present time. The incandescent electric lamp has not been in use ten years, yet it can already compete favourably in price with gas in many instances. Who can say that another ten years may not see still further improvements, more especially as the present Government has pledged itself to amend favourably the Electric Lighting Act of 1882? If this were done, and electricity placed on an equal footing with gas, capitalists would come forward, and electric lighting would obtain a fair chance of proving to the public its merits. Ten years is a short period in the life of a town. The gasworks are not likely to run away, nor is it possible for the goodwill thereof greatly to appreciate. I hold, on the other hand, that it is possible and likely that the goodwill will depreciate very considerably, and that, therefore, Edinburgh should wait —I am, &c.,

6, York-place, Edinburgh, 1st November, 1887. W. GEIPEL.

Extracts from Letters addressed to the "Scotsman" against the Purchase of the Edinburgh Gas Works

"October 10th, 1887.

"There is the fact that lighting by electricity is yet merely in its infancy.

"Why, only last winter a project was freely mooted for lighting all the shops in the line of the bridges with electric light."

Signed by D. M. JAMIESON.

"October 11th, 1887.

"Electricity can never supplant gas in the very many purposes to which the latter can be put." Signed by "AGREEMENT."

"October 12th, 1887.

"Indeed, the gas companies themselves throughout Britain now recognise that they can only compete with oil and electricity by steady and persistent reductions in their prices."

Signed by J. S. CLARK.

"October 29th, 1887.

"In my view, having regard to the present state of the keen competition between gas on the one hand and oil and electricity on the other, no more fallacious or futile argument could well be urged." Signed by J. S. CLARK.

SOUTH KENSINGTON.

EXAMINATIONS OF THE SCIENCE AND ART DEPARTMENT.

(*Continued from page 488.*)

Frictional Electricity.

25. Describe and explain the construction and action of the essential parts of Sir W. Thomson's quadrant electrometer.

Answer. Thomson's quadrant electrometer as now made consists of a cylindrical metal box, usually made of brass, completely divided into four quadrants, A, A, B, B, the two quadrants, A, A, being connected by means of a wire, and likewise the two quadrants, B, B. Within this box is a light flat movable conductor, C, of the form shown in the diagram, and usually made of aluminium, suspended so as to be capable of turning about a vertical axis.

The directive force required to give a definite position of equilibrium to the needle, when not acted on by the quadrants, may be obtained, if a single silk fibre is used for the suspension, by attaching a small magnet to the needle, or a bilifar suspension may be used, or the needle may be suspended by a single torsion fibre, such as a glass fibre, for example.

The needle is maintained at a constant high potential by being connected with the interior coating of a Leyden jar. The interior coating of the jar consists of strong sulphuric acid, to keep the air within it dry, and so enable it to retain its charge for a considerable time. The electrical connection between the jar and the needle is usually effected by means of a fine platinum wire depending from the needle, and carrying a platinum weight immersed in the acid, an arrangement which also serves as a damper to steady the vibrations of the needle.

The suspension should be so arranged that in its normal position the axis of the needle may lie in one of the two vertical planes separating the quadrants, as shown in Fig. 24.

If when the needle is charged, two conductors at different potentials be connected with the two pairs of quadrants respectively, the needle will be deflected in such a direction as to oppose more of its surface to the pair of quadrants in connection with the conductor, between which and the needle there is the greater difference of potential. This deflection will be approximately proportional to the difference in potential of the pair of conductors, and the instrument enables us, therefore, to compare the potential differences of two or more pairs of conductors. By earth connecting one pair of quadrants during a series of measurements, we make the earth

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one of each pair of conductors, and we therefore obtain the relative potentials of the different conductors, assuming the potential of the earth as zero.

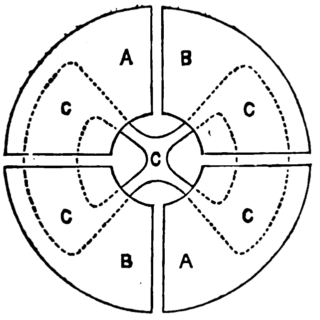

FIG. 24.

26. Two insulated metallic plates are placed facing each other, and each of them is connected with a separate gold leaf electroscope. If one plate is charged, the leaves of both electroscopes diverge. If, now, an unelectrified slab of sulphur is introduced between the plates without touching either, state and explain the effect on each electroscope?

Answer.

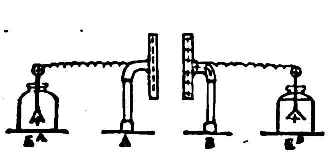

FIG. 25.

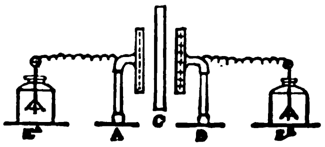

FIG 26.

Let A and B be the two insulated metallic plates connected respectively with the electroscopes E_A and E_B. Let B be charged, say, positively; then the electroscope will share this positive charge, and the electroscope E_A will become positively charged by induction.

When the plate of sulphur C is introduced between the plates A, B, its specific inductive capacity being greater than that of air, the inductive action between A and B will be increased, increasing the negative electrification of the face of A opposite to the sulphur, and therefore also increasing the positive electrification of the electroscope E_A; and again increasing the positive electrification of the face of A opposite to the sulphur, and therefore diminishing the positive charge on the electroscope E_B. The effect of introducing the slab of sulphur will therefore be that the leaves of the electroscope E_A will diverge more, and those of E_B less.

27. A metal ball, A, is placed at a distance of 1ft. from an electrified ball, B. It is then connected for a moment with the earth. If the ball A is now placed 2ft. from B, and again connected with the earth, compare the charges acquired by A in the two cases and explain the results, assuming that in each case the charges of both A and B are uniformly distributed over them.

Answer. If we assume the charges to be uniformly distributed over the spheres, we have, firstly, the potential of A inversely as the distance between the centres of the two spheres A and B; the potential in the second case, when A is 2ft. from B, will therefore be half its value when at a distance of 1ft.

Again, the effect of earth-connecting will be in each case to induce a negative charge on A of such amount as to reduce its potential to zero, the potential of the earth. The charge in the second case will therefore be half that in the first.

28. An electrical machine is placed in an insulated chamber which is lined inside with tinfoil. The rubber of the machine is connected with the tinfoil. What will be the effect upon an electroscope placed outside and connected with the chamber when the machine is in action? Explain your answer.

Answer.—There will be no effect upon the electroscope, for we know from Faraday's ice pail experiments that no interchanges, which may take place between the electrifications of different bodies completely enclosed in a hollow conductor, will produce any change in the external electrification of the conductor, provided that no alteration is made in the total amount of electricity within or upon the conductor. The fact that the electroscope remains unaffected in the case considered shows that when the electrical machine is worked, positive and negative electrifications are produced in equal amounts.

29. How would you arrange an experiment to deflect the needle of a galvanometer by a current produced by a frictional electrical machine? Would it be necessary, in such an experiment, to insulate the wires connecting the galvanometer with the electrical machine more carefully than if a galvanic cell were used in place of the machine. Give reasons for your answer.

Answer. The conductor and rubber of the machine should be connected with the binding screws of a delicate reflecting galvanometer, G, consisting of a very large number of turns of very fine wire, as shown in Fig. 27. On putting the machine in motion, the needle of the galvanometer will be deflected by the current from the machine.

It would not be necessary to be more careful about the insulation when using a frictional machine than if a galvanic cell were used,

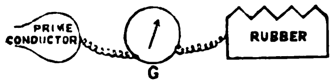

FIG. 27.

because the metallic circuit is complete in each case, and there is therefore no reason why greater care in insulating should be required in the one case than in the other.

The current will always take the path of least resistance, and when the resistance of the circuit in which we wish it to flow is very high, as is the case when the metallic circuit is broken and air or other non-conductors are interposed through which the discharge takes place by sparking, as in most experiments with the frictional machine, it is necessary to have high insulation, so that the desired circuit should still be the one of least resistance.

(To be continued.)

PRIMARY BATTERIES FOR ILLUMINATING PURPOSES.

At a meeting of the Society of Engineers, held in Westminster Town Hall, on Monday, November 7, Prof. Henry Robinson (President) in the chair, the following paper was read by Mr. PERRY F. NURSEY (past President) on "Primary Batteries for Illuminating Purposes":—

INTRODUCTORY.

If there is one branch of practical electricity the pursuit of which is more attractive to the electrician and the inventor than another, it is undoubtedly that of the generation of an electric current for illuminating purposes by means of a primary battery. Proof of this is to be found in the hundreds of patents which have been applied for in this connection during the past few years, and in the many attempts, unsuccessful and otherwise, to produce a commercially practicable primary battery during the same period. The reason for the attractiveness of the subject is to be found in the costliness of the steam-driven dynamo electric system, which, as regards small installations, and with all its excellent progress, still leaves a very wide and remunerative field open for a cheap and efficient primary battery. The prize is great, while the means of winning it would appear to be simple enough when understood. We have only to discover cheap and efficient active and inactive elements, and wed them by means of an equally cheap and efficient depolarising medium, and success is achieved. "Far more easily said than done" will be the thought now naturally passing through the minds of all. It is the author's intention in the present paper to endeavour to ascertain how far we have succeeded in producing such a battery as shall conform to the everyday requirements of ordinary life. In doing this he does not purpose pursuing the subject so much from a scientific as from a practical and an economic point of view. Scientifically speaking, the primary battery for light-producing purposes has long been a practical success. Commercially speaking it is not so yet, except in special cases, and this notwithstanding the great strides it has made during the last five or six years in that direction. In treating his subject, the author proposes first to briefly indicate the principles of the primary battery, and to outline its history, and then to describe in chronological order the various batteries of this class which he has had the opportunity of inspecting from time to time as they were introduced to public notice by their respective inventors.

After having dealt briefly with the history of the subject the author proceeded to the

CONDITIONS REQUIRED IN BATTERIES FOR GENERAL LIGHTING.

Any battery to be of use for practical electric lighting on a broad and general scale must fulfil, amongst others, the following leading conditions:—

1. It must be capable of producing a constant current.
2. It must possess a fairly high and constant electromotive force and a small and constant internal resistance.
3. The elements and the exciter should be of a simple, innocuous, and inexpensive character, and should not give out noxious or even unpleasant fumes.
4. There should be no waste going on while the battery is not doing work.

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5. It should be capable of being cleansed and replenished easily and without any kind of personal danger from any source.

6. It should be of small dimensions, and capable of being managed by the most ordinary capacity.

The Holmes and Burke Battery.

The first primary battery that came under the author's notice was that of Messrs. Holmes and Burke, which was brought out in November, 1883, and constituted then a new departure in the practice of electric lighting. All the information the author could at that time obtain respecting it was that the elements were carbon and zinc, and that the essence of the invention consisted in the mechanical arrangement of the battery and the nature of the exciter. The author saw a large room lighted by a number of Swan glow lamps of five candle-power each, which derived their current from batteries placed in an adjoining room. It was stated that a sixteen-cell battery was equal to the supply of eighteen glow lamps of five candle-power each. With regard to cost, it was stated that the light was maintained for twenty-four hours, at an average rate of one-eighth of a penny per light per hour, *i.e.*, one penny per eight hours' continuous light; but that the expense varied with the size of the lamps and the amount of electricity used. As no particulars were given of the construction or equipment of the Holmes and Burke battery, no opinion of its practical or commercial merits can be formed. It is worthy of note, however, that Messrs. Holmes and Burke were, so far as the author is aware, the first to contest the field open for primary batteries for general lighting purposes. Installations of this system have been fitted up in several houses, including that one of our members, Mr. A. F. Yarrow, who recently informed the author that the battery had worked very satisfactorily during the three years it had been in use.

The Holmes and Burke battery has lately been improved by Mr. W. Webster, jun., managing director of the Railway and Domestic Electric Lighting Company, and Mr. Octavius March, their electrician, who have afforded the author the following particulars of the improvements. The best known depolariser is no doubt nitric acid, but the difficulty of using it in a battery constantly in use has long been recognised. The depolarising fluid in the new Holmes and Burke battery is one in which the advantages of nitric acid are obtained without the disadvantages. This is done by using the materials from which nitric acid is made, in such a way that the nitric acid required for depolarisation is generated in the battery by the electro-chemical action. This generation ceases when the battery is at rest, and consequently there is never any free nitric acid present in the cell. The battery is a double fluid one, using a special depolarising fluid with carbon plates in a porous cell, and having zinc plates in the outer cell with dilute sulphuric acid. The working E.M.F. of the battery in open circuit is 1·8 volt. The fall of potential during discharge is almost nothing. The internal resistance of the sized cell generally used is 0·03 ohm. Consequently a discharge of 10 amperes can be obtained at an E.M.F. of 1·5 volt. The principal constituents of the fluid are nitrate of soda, the cheapest salt obtainable (except sodium chloride), and sulphuric acid, the cheapest acid. The cells are usually arranged in sets of eight, and provision is made for filling and emptying eight cells simultaneously.

Great difficulty is usually experienced in preventing the various connections and contacts from corroding. Mr. March finds the best method is to dispense with all binding screws, and to obtain the necessary contacts by means of mercury cups of a special form. In the latest form of battery the company have also been able to dispense with wooden tops or covers, the necessary recesses for the mercury connections being formed in the stoneware of which the cell is made. The plan now adopted also adds materially to ease of manipulation, as a zinc plate can be taken out for inspection and amalgamation at any time without breaking the main circuit.

The cost of material for maintenance may be taken to be as follows:—Sixteen cells will maintain ten 10 candle-power Swan lamps for about twenty hours. The cells usually hold about three pints of fluid per porous pot, or six gallons for the sixteen; this at 9d. per gallon = 4s. 6d.; acid for outer solution, about one gallon, 1s. 6d. = 6s. The work done would be about five electrical horse-power hours, and the zinc consumed (about 2lb. per electrical horse-power hour) would amount to 10lb. at 3d. = 2s. 6d., bringing the total up to 8s. 6d. This gives 200 lamp hours for 8s. 6d. = 0·5d. per lamp hour. The cost of a gas burner giving about the same light with gas at 3s. 6d. per 1,000 would be ·21d. It is only right to add that these conditions can only be obtained where a battery is properly attended to. Great waste naturally takes place where there is neglect. The time requisite for attending properly to a sixteen-cell battery should not exceed ¼ to ½ an hour daily for examination, and one hour for charging and amalgamating once or twice a week according to the amount of current used. By the courtesy of the Railway and Domestic Electric Lighting Company a set of eight cells, composing a Holmes and Burke battery driving twelve Swan 5 candle-power glow lamps is here in illustration of the system.

The Ross Battery.

The next example of this class of generators came under the author's notice in December, 1883. This was the primary battery of Mr. O. C. D. Ross, in which the special merits claimed were economy and constancy. In this battery zinc plates were used, and the liquid electrolytes were stated to be of an inexpensive character, and the consumption of zinc so small that it only represented a cost of 2d. per hour for the electrical unit. By a simple arrangement the cells could all be simultaneously charged with the liquid exciter, and subsequently discharged by merely raising or lowering a framework of tubes, and turning on and off a tap. The zinc which was consumed in the battery was recovered in a solid form and in augmented quantity as oxychloride of zinc. This product, it was stated, formed the principal ingredient of a new insulating material for covering electric conductors. It was found that with a single charge of the chemical liquid a substantially constant current could be obtained for upwards of twelve consecutive hours. That point was verified by the report of a professional tester, who carried out a series of experiments with a few cells forming a portion of this battery. Upon the occasion of the demonstration, at which the author was present, a Swan glow lamp, stated to be of 100 candle-power, was first shown, after which thirty-nine Swan lamps of 10 and 7 candle-power were lighted. Twenty Woodhouse and Rawson glow lamps, each of 20 candle-power, were subsequently shown, and during the time they were running the current was switched on to a motor which drove a 16in. Blackman ventilating fan, with but slight detriment to the light of the twenty glow lamps. A powerful arc lamp was also brought into action, all the other sources of consumption of current being of course switched off. In all cases the light was of good quality and very steady, and in these respects the demonstration was very satisfactory. The arrangement for charging and discharging the cells was very good, but the battery was very large in proportion to power, and emitted a decidedly objectionable smell. The nearest approach to an estimate of the cost of the light produced was that it was slightly more expensive than gas. As the battery was working in the City of London the price of gas may be put down at 3s. per thousand. Mr. Ross recently informed the author that his battery had been successfully applied to the lighting of a house in Queen's-gate for two years. Mr. Ross, however, does not now attach any importance to the recovery of the oxychloride of zinc as a by-product, for the reason that in house lighting the quantity would be too small to make it worth collection. Mr. Ross informs the author that quite recently he has made a discovery in connection with the action of the separate cells of his battery which will greatly simplify the daily manipulation of discharging the spent solution and replenishing the cells with fresh.

The Coad Battery.

In January, 1884, the author inspected the working of the Coad primary battery, which had been publicly exhibited previously, and had then recently undergone several modifications and improvements. No particulars were given as to its construction beyond the statement that the battery had a specially prepared zinc immersed in a special liquid exciter, one feature being that the zinc was not removed from the bath during non-use, there being, it was said, no waste. The battery appeared to be of small size for its power, inasmuch as two batteries of ten cells each were contained in a case 3ft. high by 2ft. wide and 20in. deep. Each 10-cell battery was said to be equal to the supply of one Swan glow lamp of 20 candle-power, and it was stated that the battery would give a full light for forty hours, after which it had to be recharged with the liquid. The cost of maintaining a battery of ten cells for forty hours was put at 1s. 3d., and each cell was said to yield a large quantity of chrome. The glow lamps gave an excellent light, and so far as it went the demonstration was very satisfactory. The author, however, has not heard of this battery since the date given, and his recent attempts to trace it have proved futile

The Lalande Battery.

About the middle of 1884 a considerable amount of attention was being directed to the Lalande-Chaperon primary battery, by means of which it was claimed that a current of electricity could be generated and used either for lighting or for driving machinery, and that certain of the elements which produced the current became converted during the time they were doing their work into a substance of greater value than they possessed before the battery was started. The battery was somewhat large, that which the author inspected being composed of forty-eight cells, each 1ft. cube. It was stated that the battery was capable of maintaining fifteen glow lamps of 10 candle-power each, or of driving a small motor. Each cell of this battery consisted of an iron tray, on the bottom of which was placed the depolarising agent, which was oxide of copper. Just above this and supported at each corner was a plate of zinc, the cell being filled with a solution of caustic soda. Under ordinary circumstances, and when the circuit was open, no action took place between these elements; but on the circuit being completed the work of decomposition commenced. The oxygen of the oxide of copper combined with the zinc and formed oxide of zinc, metallic copper being left behind. When the battery was exhausted the zinc was recovered from the liquor in the form of an oxide, and this was stated to be 56¼ per cent. more valuable than the metallic zinc, and was to be used for making paint and for other industrial purposes. This remarkable increase in value was said to be obtained by reason of the metal having gained 25 per cent. in weight by its absorption of oxygen, and the oxide being also 25 per cent. more valuable than the metal, weight for weight, thus giving a total increase in value of 56¼ per cent. as stated. The oxide of copper was to be revivified and used over and over again. The claims mainly advanced for this battery were, that it was absolutely constant so long as the elements in it were kept in a state of efficiency; that the action upon the zinc was very gradual, that while the light was not being used there was no waste going on, and that no noxious smell was given off, as is the case when acids are used. This latter point was clearly demonstrated upon the occasion of the author's inspection, as was also the ability of the battery to give an excellent and steady light. A series of nine Woodhouse and Rawson glow lamps, each of 10 candle-power, were used in circuit. An Ayrton and Perry's motor was driven by the current, and showed the battery to be capable of doing good work in that respect. The cost of the light produced was stated to be much less than that of gas.

Although the battery is the invention of M. Lalande, the credit of attempting to utilise the residual product from it is due to Mr. J. Berger Spence, head of the firm of manufacturing chemists bearing that name. And it came about in the following manner:—The manufacture of oxide

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of zinc is in ordinary a costly process, and Mr. Spence had for some time past been casting about for a more economical method. Amongst other things, he tried electrical decomposition; and, whilst engaged in his experiments in that direction, he became acquainted with M. Lalande, who, he found, had a battery which was giving exactly the result Mr. Spence wanted. The introduction of the battery for lighting purposes, however, is due to Mr. Hugh A. Fergusson, under whose hand it has been considerably modified and improved since the author saw it in June, 1884.

In the improved battery the elements consist of zinc, caustic potash, and oxide of copper. The cell consists of a cast-iron trough, 24in. long, 12in. wide, and 18in. deep, holding about 15 gallons of liquid. The negative plate (positive pole) consists of folded iron gauze, into which is pressed an agglomerate mixture of oxide of copper, in a granular form (copper scales), and chloride of calcined magnesia in certain proportions. This, when heated, forms a hard porous plate. The oxide of copper acts as a depolariser, and is the essential feature of the battery. When the battery is worked out the copper is left in metallic form, and by heating the plates in a furnace it is reoxidised, and again ready for use. The size of the plates is 20in. long by 18in. deep, and ⅜in. thick. There are four in each cell, presenting a working surface in liquid of about 1,280 square inches. Each plate contains about 10lb. of copper, or 40lb. per cell.

The positive plate (negative pole) consists of a zinc plate, of which there are two in each cell, the dimensions of each being 20in. by 15½in. by ¼in., and weighing 20lb. or 40lb. the two in each cell. The working surface is about 1,240 square inches. The exciting liquid consists of a solution of caustic potash at a specific gravity of between 1·25 and 1·3. The electromotive force through high resistance is stated to be slightly under one volt. In the earlier experiments the lamps were run direct from the battery, and although this answered very well in many cases, there were found to be objections to this method. The battery is therefore now worked in combination with another battery of secondary cells or accumulators, which are charged in parallel from a set of six primary cells in series. This system of charging accumulators in parallel is found to answer very well, as the cells are more evenly charged than in the series system. The secondary cells are connected to a switch for turning them into series and on to lamp circuit, or in parallel and on to battery circuit. By this means not only are the objections connected with running a lamp circuit direct from primary cells avoided, but there are said to be collateral advantages of great importance in connection with the system.

Several installations of the Lalande system have been fitted up in London and elsewhere, and are reported to have given every satisfaction. In practice the cells are placed in a cellar, from which there is an opening to the street sufficiently large to pass the plates and primary cells through. When the solution had become saturated with zinc, it was formerly removed by means of a tank cart, in which the exhausted solution was put. In the future, however, a vacuum cart is to be used in order to save time. By this means a battery of six cells, holding 90 gallons, will be emptied in 10 minutes. The company working the invention will maintain the batteries, and the carts will visit the houses where they are in use at stated periods to re-charge them whenever it is necessary. The specific gravity of the solution in the primary cells acts as a reliable indicator of this. The solution is to be taken to the works, where it will be treated in two ways. First, by the process invented by Dr. Squire, by which the zinc is obtained back in the form of sulphide of zinc, and is sold for paint purposes; and, secondly, by the process invented by M. de Lalande, by which, it is said, the zinc is obtained back in a greater state of purity than when it was originally put into the battery. The caustic solution will also be returned to its original condition, and the oxide of copper gauzes will be re-oxidised for further use. This latter process has only been completed within the last few months, and by its means it is claimed that electricity can be supplied at a lower cost than has yet been supposed possible. The Lalande system, as a whole, has been examined by several scientific men, and the reports that have been made by them are very satisfactory. The reporters, as regards the electrical part of the system, were Prof. Tait and Prof. Crum Brown, of Edinburgh, and Principal Jamieson, of Glasgow. The chemical part has been examined by Prof. Dittmar, of Glasgow.

The Lalande system is illustrated by a battery of six cells, with lamps running, which Mr. Fergusson has kindly placed at the author's disposal upon the present occasion.

The Skrivanow Battery.

The attempt which was made in the early part of 1885 to destroy the Houses of Parliament by dynamite led to the introduction to public notice of a new search light driven by a primary battery, and designed for use in small boats on rivers. It was introduced by Mr. Isidore Spielmann, who about the time stated experimented with the apparatus, which was in the first instance intended for the use of the river police in patrolling the Thames opposite the Houses of Parliament. The object was to throw a strong light from the middle of the river on to the Palace of Westminster. The difficulty to overcome was the obvious one presented by the size of the police boats, which does not admit of their being fitted with engines, dynamos, or bulky accumulators. The only source left was that of the primary battery, and from this was derived the light with which the trials were made. The battery used was the invention of Mr. George de Skrivanow, a Russian inventor, who died about that time. The elements of this battery consist of a small packet of chloride of silver and two plates of zinc placed in each cell with a weak solution of caustic potash. In applying this battery to domestic lighting, a small one is placed in the stand of a moderator or other similar kind of lamp, which can thus be utilised for the purpose, a glow lamp being fixed on the top in place of the ordinary burner. The author inspected a number of lamps thus arranged. Taking one as typical of the rest, he may explain that it had a battery consisting of three boxes, each measuring only 4in. by 2in. by 1in., and which supplied the current to a glow lamp of Italian manufacture, the light being an exceedingly good one. It was stated that it would burn for twelve hours with undiminished brilliancy, but that at the end of that time the silver would be converted into pure silver, and would require to be revivified. This is effected by washing it in a solution of nitric and hydrochloric acid. It is then replaced in the battery for further use, there being no waste of the silver. The marked advantages of this system of domestic electric lighting, beyond the portability of the lamps, are the absence of fumes, the small battery capacity, and the great electromotive force, this being 1½ volt for each cell, which is only 1in. in width. Applied to the arc system, the Skrivanow battery showed its power, a light of 250 candles being produced from a couple of batteries measuring 10in. long by 8in. wide and 6in. high. This installation, which the author also inspected, was, in fact, the one already referred to as having been used as a search light on the Thames by the police.

The Skrivanow battery was also applied to a miner's lamp, and an example was brought under the author's notice in January, 1886. This lamp consisted of a metal casing 7in. high by 3½in. wide and 3in. deep from front to back, and which contained the battery. Projecting from the front of the case was a 3-candle glow lamp of German make, and which was properly protected, and had a reflector. The battery was composed of three cells, each 6in. by 3in. by 1in., and produced an excellent light of 3 candle-power, which, it was stated, would last nine hours. The current given off by this battery was in excess of the requirements of the miner; but there were smaller lamps, notably one of circular form 3in. in diameter and 3in. deep, and of 2 candle-power, burning for five hours. Another, of the quadrangular type, was 6in. high, and of 3 candle-power, but only burning for seven hours and a-half. The cells were hermetically sealed, so there was no fear of escape of the liquid portion of the contents, and the lamp could be inclined at any angle without fear of extinction.

(To be continued.)

PROF. SILVANUS P. THOMPSON ON TECHNICAL EDUCATION.

A conference on technical instruction was held at the City and Guilds Technical College, Finsbury, on Saturday evening last, under the presidency of Mr. J. Rowlands, M.P. Prof. Silvanus Thompson, Principal of the College, read a paper upon "The Present Position of the Technical Instruction Question." He began by giving a brief outline of the efforts that have been made during the past decade to supply technical education by the development of real technical schools in many of the principal provincial towns, and by the establishment of technical, or at least of technological classes, out of the old "mechanics' institutes." Simultaneously with these there had grown up what are known as university colleges, which, he said, were of a more purely scientific character, and which afforded the means of acquiring real technical education, more particularly in those cases where schools of engineering had been developed. The problem of technical instruction could not, however, be solved by the establishment of a dozen science colleges. They met the wants of a very small portion of the population. For the vast majority, for those who must be apprenticed to a craft, they did nothing, at any rate directly, save in those cases where by the holding of evening classes they met the wants of those who discovered—often, alas, too late—how little their previous education had fitted them for their career in life. The lecturer then proceeded to sketch the difference in the grade of instruction imparted at the numerous institutions in the metropolis wherein educational work of a technical character is going on, and gave an exhaustive history of the Finsbury Technical College, its objects, and the methods of instruction therein adopted. Briefly stated, he said that three points might be emphasised:—Firstly, all the instructors of the Finsbury Technical College are men who have learned their work from the industrial side, and who can therefore show how theory can be applied to practice; they are trained workers endeavouring to teach the principles of their craft, not schoolmasters trying to teach trades. Secondly, the main work of the college is conducted, not in the lecture room or class room, but in the laboratories, workshops, drawing office, and studios. Thirdly, there is no cramming for examinations, therefore none of the baneful effects of striving after payment by results; no inducement to superficialism or dilettanteism; in a word, students and instructors alike come to the college not for amusement but for work. Prof. Thompson next went on to comment upon the great strides that have been made in recent years on the Continent with regard to the subject of technical instruction, making special reference to the Technical High School of Berlin, the cost of which, he said, including its magnificent collection of apparatus, casts, models and instruments, was about £690,000, the annual grant to which on the part of the municipality being £37,380. It had a staff of 58 professors besides 43 assistants. The main subjects of instruction taught were architecture, building, engineering, chemistry, photography, metallurgy, physics, and electrical engineering. The expenditure for its maintenance was made up as follows:—Salaries of 58 professors and 43 assistants and instructors, £16,000; apparatus and materials, £3,000; maintenance of building, £1,050; office expenses and postage, £6,190; heating and ventilation, &c., £3,000; library, £730. He was far from saying that the City of London ought to copy the City of Berlin. Much less would he propose, on the ground that London was four times the size of Berlin, to erect a building four times as great. On the contrary, he maintained that as Englishmen their business was to develop their own system to meet their own needs. Only let them keep their eyes open to the magnitude of the efforts made to wrest from them their industrial supremacy by providing such ample means of acquiring technical

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instruction. He next proceeded to examine the wide question of apprenticeship, of which he said there were only two recognised kinds in this country. In one, the apprentice, entering at about 14 years of age, served seven years as a workman, receiving practically nothing for his work beyond instruction in his trade, save a small pittance for his weekly maintenance. In the other the young man was received into the works at the age of eighteen or nineteen as a premium pupil, to serve an apprenticeship of a very different and often very unsatisfactory kind. But now it would seem there was a third sort of apprenticeship in which the technical college or school played a part—the work of the technical school or college being either preparatory or supplementary to the commercial apprenticeship in the shops. The aim of the Finsbury College differed from other institutions of the same class in this, that its two years' course was designed to obviate the payment of a premium, and to enable the student, when at about the age of seventeen he entered the works, to take his place there as a working apprentice, the same as if he had been already apprenticed there for three years. In other words, it was an attempt to create a modified apprenticeship, lasting not more than five years, wherein the college course took the first two and the shops the last three. The success of the system had already passed the expectation. Another most important question arising out of the consideration of the present position of technical instruction was the form to be given to its future organisation, and to complete anything like a national organisation the following additional departments to the Education Department would require to be organised :—A Department of Secondary Education, including under its operations three classes of schools or colleges, namely—(1) Higher literary or grammar schools ; (2) Technical schools and colleges ; (3) Schools of commerce. A Department of Higher Education, including under its supervision—(1) Normal schools for training teachers ; (2) University colleges of the modern type ; (3) the several universities of Great Britain. The organisation of secondary education was a matter of absolutely vital importance in this country, but one of which, in the clamour of party politics, scarcely a syllable was heard. What was the best form to give to the national organisation of technical instruction ? At present there appeared to be three claimants to the honour of directing it in the future—(1) the City and Guilds of London Institute, (2) the National Society for the Promotion of Technical Education, and (3) the Department of Science and Art at South Kensington, the characteristics of each of which he fully set forth, pointing out with regard to the latter that the very objects at which it aimed were defeated by the stereotyped methods and ideas of the official mind that governed it, which had the tendency to divorce the artist from the workman, which was the very thing that true technical education deplored and sought to remedy. In conclusion Prof. Thompson said :—"What, then, must be done for the national organisation of technical instruction ? In the writer's opinion the first and most important point of all is to secure the creation of a real Education Department under a real Minister of Education. At present we have no Minister of Education, only a Vice-President of Council, whose duties appear to be extensive and peculiar. They comprise apparently the work of looking after the regulations for statute fairs and diseases of cattle, of supervising the Elementary Education Department and the Science and Art Department, and of superintending the proceedings of the Judicial Committee of the Privy Council. What is wanted is a real Minister of Education, presiding over an organisation in which the Elementary Education Department, the Science and Art Department, and the Departments of Secondary (including Technical) and Higher Education, should all take their appropriate places under officials responsible directly to the Minister himself, and not to that mysterious body "My Lords of Council.' No attempt by Parliament to organise technical instruction can be satisfactory unless it involves the appointment of a responsible Minister of Education, and a reconstruction of the whole departmental machinery."

A brief discussion followed, in which several working men took part, the general consensus of opinion being that technical education, as represented by Prof. Thompson, would eventually tend, by the superior workmanship that it would call forth (thereby defeating foreign competition), to benefit not only the workman but the public at large.

Votes of thanks were afterwards passed to Prof. Thompson and the Chairman, and the proceedings terminated.

LEGAL INTELLIGENCE.

Smart, Block and Co. v. United Telephone Company (Limited).

This action was on Monday last heard before Mr. Justice Mathew and a special jury.

The plaintiffs, who carry on business in London-wall as importers of Swiss embroidery, &c., claimed to recover damages for injury caused to their goods, as they allege, through the falling of a telephone wire belonging to the defendants during the great snowstorm which took place at the end of December, 1886. The wire in question was stretched over the roof of the plaintiff's premises, and the allegation was that in its fall it knocked away a gutter, and in consequence the water from the melting snow entered the warehouse.

The defence was that the weight of the snow caused the gutter to fall, and that the wire had nothing to do with it.

Mr. Crump, Q.C., and Mr. Morten appeared for the plaintiffs ; and Mr. Moulton, Q C., and Mr. Daniels for the defendants.

The Jury returned a verdict for the plaintiffs, damages £300, an agreed amount.

Judgment accordingly.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names with inparentheses are those of communicators of inventions.*

14,893. L G. WOOLLEY. London. Improvements in generation of electricity. November 1, 1887.

14,894. J. M. V. MONEY-KENT and S. SHARP. London. Improvements in and connected with the construction and use of transformers and similar apparatus November 1, 1887.

14,901. C. R. GOODWIN. Paris. Improvements in electric batteries. November 2, 1887.

14,996. E. HOPKINSON. London. Improvements in gear for transmitting motion from electric motors to driving axles of vehicles. November 3, 1887.

15,006. R. BUTCHER and E. ROUSSEAU. London. An improved electric switch. November 3, 1886.

15,063. D. S. KRIVANOW. London. Improvements in galvanic batteries. November 4, 1887.

15,078. J. HARGREAVES. London. Improvements in thermo dynamic engines. November 5, 1887.

15,095. S. EVERSHED and W. T. GOOLDEN. London. Electro dynamic apparatus for controlling motion. November 5, 1887.

15,117. J. M. V. MONEY-KENT and S. SHARP London. A new or improved electric motor. November 5, 1887.

15,136. S. S. BROMHEAD. London. An improved electric torch for lighting fires, lamps, etc. November 7, 1887.

15,141. A. F. ST. GEORGE and C. R. BONNE. London. Improvements in galvanic batteries. November 7, 1887.

15,153. J. SINCLAIR and J. P. REES. London. Improvements relating to electric safety lamps. November 7, 1887.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

November 5th, 1887.

5,292. H J. ALLISON. London. Improvements in electric motors (The Baxter Electric Manufacturing and Motor Company, United States). April 12, 1887.

5,462. W. H. SCOTT and E. A. PARIS. London. Improvements in dynamo-electric machines. April 14, 1887.

November 9th, 1887.

395. C. L. M. DÉRI and O. T. BLATHY. London. Improvements in induction coils or transformers. January 10, 1887.

13,509. C. BELL. Glasgow. Improvements in and relating to telephonic apparatus (L. M. Ericsson). October 5, 1887.

PATENTS SEALED.

November 1, 1887.

13,712. A. M. CLARK. London. An improvement in dynamo-electric machines (The Electrotechnische Fabrik Cannstatt, Germany). October 26, 1886.

13,978. C. D. ABEL. London. Improvements in coupling two or more alternate current dynamo electric machines with a main circuit, and apparatus therefor (Siemens and Halske, Germany). October 30, 1886.

9,196. A. J. BOULT. London. Improvements in apparatus for changing or regulating electric currents (Dr. Stefan Doubrava, Austria). June 28, 1887.

9,737. W. P. THOMPSON. Liverpool. Improvements in or relating to electrical distribution and conversion (G. Westinghouse, jun., United States). July 12, 1887.

9,738. W. P. THOMPSON. Liverpool. Improvements in or relating to electrical distribution and conversion (G. Westinghouse, jun., United States). July 12, 1887.

9,740. W. P. THOMPSON. Liverpool. Improvements in or relating to electrical distribution (G. Westinghouse, jun., United States). July 12, 1887.

November 4, 1887.

10,868. J. LEE and H. R. HAMMOND. London. Operating on zinc ore for producing chlorine ; also zinc and the utilisation of said zinc for coating metals galvanically. August 25, 1886.

12,818. W. W. BEAUMONT. London. Improvements in secondary batteries. October 8, 1887.

3,990. C. CLAMOND. Paris. Improvements in micro-telephonic transmitters. March 16, 1887.

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9,739. W. P. THOMPSON. Liverpool. Improvements in or relating to electric circuits and automatic controlling apparatus therefor (G. Westinghouse, jun., United States). July 12, 1887.

9,745. W. P. THOMPSON. Liverpool. Improvements in or relating to converting electric currents into currents of different potential (G. Westinghouse, jun., United States). July 12, 1887.

SPECIFICATIONS PUBLISHED DURING THE MONTH.

16,157, 1886.—A. SLATTER. Electrical switch. (Price 8d.)

16,201, 1886.—R. DICK and R. KENNEDY. Transforming and distributing electric energy, &c. (Price 8d.)

16,326, 1886.—R. DICK and R. KENNEDY. Transforming and distributing electric energy. (Price 8d.)

16,408, 1886.—A. J. BOULT (Dujardin). Electric accumulators. (Price 8d.)

16,456, 1886.—H. A. and H. A. HOUSE. Electrophonetic telegraph sounders. (Price 8d.)

10,056, 1887.—W. WALKER. Automatic electric railway signalling. (Price 8d.)

12,189, 1887.—H. H. LAKE (Graves). Electrical transmission sound. (Price 8d.)

12,190, 1887.—H. H. LAKE (Graves). Telephonic apparatus. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

The "Pilsen," "Joel," and General Electric Light Company (Limited).

The sixth ordinary general meeting of the shareholders of the above Company was held at the Cannon-street Hotel on Thursday, the 10th inst., under the presidency of Sir Rawson W. Rawson, K.C.M.G., C.B.

The SECRETARY (Mr. W. H. Trentham) read the notice convening the meeting, and the Directors' report and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen, I shall not detain you by many observations. Our object to day is mainly to sanction the dividend which the Board are able to propose to you. That dividend is but a small one. We had hoped that it might have been at least equal to that of the preceding year, but the circumstances of last year have not been favourable for electric lighting generally either with ourselves or with other companies. Our object, as you know, from the beginning has been to carry on our business with the capital that was left to us without calling upon our shareholders to increase it. Our capital, as is shown in the report, is but a very small one—not exceeding £7,000—and we have been desirous of entering upon no speculative business, of uncertain return, which should diminish that small capital. We see, like other companies, a future for electric lighting, but until some Bill passes the Legislature there can be no large development of the distribution of electricity for lighting purposes. At the present time it seems rather that people are desirous of receiving electricity as they do gas, and that the prospect of profitable investment of our capital is in the way of installations. We have therefore, since our last meeting, formed a new installation at the head of Tottenham Court-road, which, we feel assured, will be a profitable investment and will increase in profit. We have removed our offices from the small building and factory in which they were placed to other premises in Stanhope-street, where there are the means of developing our business to a very considerable and safe extent. We have already had a profitable return for our investment there, and have the prospect amongst the surrounding tradesmen of increasing our profit from that installation considerably. It is very satisfactory that Mr. Baker, who was our original customer in Holborn, has shown that he was so far satisfied with his installation there that he has extended it to another of his establishments. In the same way at Holborn we have increased our means of obtaining customers there by putting in a more powerful engine, which will enable us to run our circuit into Fleet-street and elsewhere, and there we find another proof of the satisfaction that we are now able to give to our customers, inasmuch as Mr. Baker has again entered into a contract to extend the lighting to his establishment in Fleet-street. In the same way other large customers in Tottenham Court-road and Fleet street have contracted to light their establishments. We therefore see for the future the probability—I may say the certainty—of increasing considerably our annual profits, and being able to distribute a larger dividend in future years. But, at the same time, as has been already remarked, our capital is very small, and, as you know, in order to obtain an annual profit from our installations, we must invest a considerable amount of money in the installations themselves, and we therefore feel ourselves at present limited in our operations by the amount of our capital. Your attention has been called in the report to that point and to another in our affairs, namely, the shares that have been forfeited. I do not know that I have anything else to call your attention to, but I may wind up by expressing our feeling of confidence with regard to the safe and profitable working of the Company with its present small capital; and if electric lighting shall become more popular, and there shall be evidence of a desire on the part of persons to avail themselves of it, and we can see our way to a profitable extension of our business, it will be our duty to avail ourselves of every means now at our disposal to extend our business safely, and if those means are not sufficient to call your attention at the next meeting to the circumstances, and to invite your opinion as to the advisability of taking some steps to increase our scope of obtaining a larger profit for our shareholders. He concluded by moving the adoption of the report and accounts.

Mr. HORACE W. SCRIVEN seconded the motion.

Mr. ROSS asked what was the cost of the installation at Tottenham Court-road.

The CHAIRMAN replied that it was about £1,200.

A SHAREHOLDER asked whether the money invested in Consols was available for such purposes?

The CHAIRMAN: Certainly. You can quite understand that it is very much more satisfactory to us to profitably use our money in Consols than to leave it invested at 3 per cent., and therefore you may count on our using these funds as far as we safely can. We must of course always have a certain reserve to meet the opportunity of entering upon some larger enterprise. In further answer to a shareholder he added:—Last year the sum invested in Consols on the 30th of June was £3,500, and on the 30th June, 1887, it was £2,986—a diminution of a little over £500. That amount has been diminished since, and the cost of the engine at Holborn will have to be met out of the Consols.

Mr. SCRIVEN said that they might regard the Consols as working capital.

The resolution was then put to the meeting, and carried unanimously.

The CHAIRMAN next moved, and Mr. ROSS seconded, "That a dividend on the present paid-up capital of the Company, at the rate of 4d. per share on the partly paid-up shares, and at the equivalent rate of 7d. per share in respect of the 100 fully paid-up shares, be sanctioned."

The resolution was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. SCRIVEN, the retiring Director, Mr. George Lovinge Whateley, was re-elected to his seat at the Board.

Messrs. Brown, Hays and Akers were subsequently reappointed auditors to the Company, and a vote of thanks having been passed to the Chairman and Directors, the proceedings terminated.

The Imperial Continental Gas Association and their Electric Lighting Plant.

The half-yearly ordinary general meeting of the proprietors of this Association was held at the City Terminus Hotel, Cannon-street, on Tuesday afternoon, Sir Julian Goldsmid, Bart., M.P., in the chair.

The following is the only portion of the proceedings which will be of interest to our readers:—

In the course of his remarks the CHAIRMAN said: You have been informed at previous meetings that we were going to light the Opera and the Burg Theatre at Vienna by the electric light. When we undertook to go into that matter we did not do so with the idea of making a big profit, but simply to satisfy the local and imperial authorities. Although there may be many imperfections in what has been done, yet I trust, after the whole undertaking is completed, the installation will work satisfactorily. We are not the first and only gas company that has found it necessary to enter upon electric lighting. It is not so good a thing as gas lighting, and our main reliance must be upon our original specific business—that of supplying good gas light at the cheapest possible price.

Mr. GEORGE LIVESEY: I think, Mr. Chairman, your remarks about the electric lighting of Vienna require a little explanation to satisfy the shareholders that it is right. Of course, I do not pretend to understand much about the working of foreign gas companies. If it were an English company I should speak very decidedly, positively, and emphatically against any gas company in the United Kingdom undertaking electric lighting. Whether your circumstances are different it is not for me to say. I have no doubt that you have acted with great discretion in the matter. I read an account from *The Times* correspondent, some months ago, on the success of this electric installation at Vienna. It said something to the effect that the engineer of the gas company had had great difficulties to contend against, but had succeeded in overcoming them, and I gathered from this report that the engineer of the Imperial Continental Gas Association of London had given the greatest possible help to electric lighting—our great rival. Well, I will not say rival, for I do not believe it is such; but, at all events, by the great skill which this Company's engineer brought to bear upon the matter he had overcome obstacles and difficulties that had puzzled the electricians. I thought that was a very strange thing—that a gas company should undertake to do for electricity what it could not do for itself. Also, I thought that this electric lighting was not productive of profit, and it looked to me as if there was a danger of the profits earned by the legitimate undertaking of the Company being used to bolster up the electric lighting. Further, it occurred to me, why could not the Company have left this electric lighting alone? If the Emperor was determined to have the electric light, by all means let him have it, but do not let the Company be dragged into supplying it. You have stated that you do not expect to make any profit out of the electric light; then what on earth was the use of going in for it at all, unless, indeed, there was something connected with the concession of the Company and the Emperor that rendered it expedient to do so? You have said that we were not the only gas company that had gone in for the electric light. I read of one lately in Italy that bought up the electric company's shares in order to control its working. I think that was another great mistake. Why cannot gas companies leave the electric light companies alone—leave them to do their best or their worst, or fight them legitimately? In England there is no chance of gas companies going in for this electric lighting. Some time ago an English company attempted to get powers

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to supply electric light, but the Board of Trade opposed the Bill in Parliament; they refused to grant the necessary powers, and the result was that no further attempt was made. My opinion is that gas companies will be able to hold their own, and hold their own against all competitors.

The CHAIRMAN: As far as I am concerned, I have at previous meetings told the shareholders that I am not in favour of going into anything that will not give us a good return for our money. There were special reasons at Vienna that made it desirable for us to accede to the wishes of the imperial and local authorities—not, indeed, with the view of profit, but to keep the position we already occupied. If we can show our competitors what the cost of an electric station is, and what return it is likely to give, they will not be so likely to enter the field as otherwise they would be. That is a result not to be overlooked. With a good many years' experience of this Company, I am strongly of opinion that it was desirable, under the circumstances, to undertake this work. Of course, the business of the Company cannot be measured by the position and method of management of companies in England under statutory powers, and which exist for ever and ever. In the case of foreign companies, you have affairs to arrange and settle with municipal and other authorities that never occur to English gas managers.

The report was then put and carried unanimously.

West India and Panama Telegraph Company.

Report of the Directors to be presented at the twenty-first ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, E.C., on Wednesday, the 16th inst., at 12 o'clock:—

The amount to credit of revenue is £47,003. 7s. 4d., and the expenses have been £25,543. 4s. 4d., leaving a balance of £21,460. 3s., which, with the balance of £1,919. 15s. 6d. brought from last account, makes a total of £23,379. 18s. 6d. Of this sum the Directors have placed £6,000 to reserve, leaving an available balance of £17,379. 18s. 6d., with which it is proposed to deal as follows:—

Payment of 9s. per share on account of arrears of dividend on the First Preference shares	£15,553	7	0
Balance to current half-year's account.............	1,826	11	6
	£17,379	18	6

The traffic receipts for the six months show an increase of £1,792. 2s. 7d., as compared with the corresponding period. The Company's ss. "Grappler" came to London in June last, and, after being docked and overhauled, returned to the West Indies with 250 knots of deep-sea cable for repairing purposes. She has since repaired the original Jamaica-Po to-Rico section, which was interrupted on the 28th November, 1885. With the completion of this repair the duplication of the most important section of the Company's line is restored. The shareholders were informed in the last Report that the Directors had addressed communications to the French Government, pointing out the inevitably disastrous financial results of the proposal which had been submitted to the French Chamber of Deputies, to authorise the guarantee of a gross revenue of £40,000 per annum for the construction of a cable between Para (Brazils) and New York, touching, among other places, at the French islands of Martinique and Guadeloupe, already served by the system of this Company. The directors have now to report that, notwithstanding persistent efforts in favour of the scheme, the evidence of its unremunerative and unnecessary character was so overwhelming that the French Chambers decided not to proceed with it. With the experience of this Company of the insufficiency of West India traffic to support a remunerative telegraphic system, it is surprising to find attempts made to compete for a portion of a business, the whole of which does not yield a dividend on the larger part of the capital employed. Any proposal for the establishment, on commercial grounds, of a competitive line, if put forward with a view to any profit to those who might be induced by promoters' representations to find the necessary capital, has only to be impartially examined to be rejected. The whole of the £50,000 debentures which fell due on the 31st December last has now been extended for a further term of five years at 5 per cent. per annum, instead of 6 per cent.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended Nov. 4th amounted to £3,492.

EASTERN TELEGRAPH COMPANY.—This company notifies that it has opened for traffic a new cable between Porthcurnow in Cornwall and Gibraltar, Malta, and Zante, thus putting Greece and Turkey in direct cable communication with this country. The rate to Greece is the same as by the existing land routes, viz., 7½d. per word. To Turkey the rate is 10d. per word.—The same company also notifies the opening of a new telegraph station at 37, Holborn-viaduct, where telegrams will be accepted for transmission to all parts of its system.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY.—This company gives notice that on Wednesday, 16th inst., at 2 p.m., at the company's offices, Winchester House, 50, Old Broad-street, 257 First Mortgage Debentures of £100 each will be drawn for payment on 2nd January, 1888. Notice will be given by advertisement of the numbers of the debentures drawn.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this company for October amounted to £23,160. From 1st January to 31st October, 1887, they amounted to £220,880; for the corresponding months of 1886 and 1885 to £217,800 and £241,640 respectively.

OPPERMANN ELECTRIC LIGHTING AND MANUFACTURING COMPANY (LIMITED).—The prospectus of the Oppermann Electric Lighting and Manufacturing Company (Limited) has been issued. Capital, £20,000, of which a first issue will be made of 1,000 shares of £5 each. The company is formed for the purpose of taking over the business of electrical engineers now carried on by M. Carl T. J. Oppermann under the name of Lawrence Oppermann, at Crown Works, Amhurst road, Hackney. The works will, however, be removed to Blockley, Worcestershire, where water power is available. The following agreements have been entered into:—(*a*) An agreement, dated the 14th day of October, 1887, between Carl Tunstill John Oppermann of the one part, and Lord Edward Spencer Churchill, on behalf the company, of the other part; being an agreement for the purchase of the business, as stated in the prospectus, for the sum of £1,200, and for securing the services of Mr. C. T. J. Oppermann as manager. (*b*) An agreement, dated the 22nd day of October, 1887, between Hugh Nigel Warburton, of the one part, and Lord Edward Spencer Churchill, on behalf of the company, of the other part. (*c*) An agreement, dated the 22nd day of October, 1887, between Charles Barter of the one part, and Lord Edward Spencer Churchill, on behalf of the company, of the other part. Directors: Lord Edward Spencer Churchill (chairman), Alexander Wm. Hall, Esq., M.P.; Rev. Henry Barter, H. N. Warburton, Esq., C. Barter, Esq., C. T. J. Oppermann, Esq. The last three will join the board after allotment.

SOUTH AFRICAN GAS COMPANY (LIMITED).—This company has been registered with a capital of £100,000 in £5 shares. The objects of the company are to manufacture and supply gas and light in Woodstock and elsewhere in Cape Colony; to carry on at Woodstock the business of an electric light company in all branches, and to carry on the business of electricians, mechanical engineers, and suppliers of electricity for light, heat, motive power, or otherwise.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended 31st October amounted to £3,700.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended November 4th, were £2,580, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

REMOVAL.—Messrs. P. Walters and Co., telegraph-engineers and contractors, notify that they have removed their offices from 278, Roman-road, Bow, and have entered into new premises at Blenheim-street, Chelsea, S.W.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. NOV. 9.		BUSINESS DONE WEEK ENDING NOV. 9. Highest.	Lowest.
Anglo-American	38½,	39½	40	39xd.
Do. Preferred	63½,	64½	66¼	64xd.
Do. Deferred	14,	15	15¼	14¾
Brazilian Submarine	11⅝,	11⅞	11 13-16	11½
Cuba	11¾,	12¼	12	—
Do. Preference	18,	19	19	—
Direct Spanish	2¾,	3¼	3 1-16	3
Do. Preference	8,	9	—	—
Direct United States Cable	9⅛,	9⅜	9¼	—
Eastern Telegraph	11⅛,	11⅜	11 5 16	11⅛
Do. 6 per Cent. Preference	13¾,	14¼	14¼	14
Do. 5 per Cent. Debentures, 1899	106,	109	107½	—
Eastern Extension	11⅝,	11⅞	12	11¾
German Union	10½,	11	10¾	10⅝
Globe Telegraph and Trust	5⅝,	5⅞	5 13-16	5 5-16
Do. Preference	13⅛,	13⅜	13⅜	13⅛
Great Northern	13½,	14	—	—
Indo-European	36,	38	—	— xd.
Reuter's	8,	8½	—	—
Submarine	170,	180	177½	171
West India and Panama	¾,	1	—	—
Do. 1st Preference	9½,	10	9⅞	—
Western Brazilian	7¾,	8	7 15-16	7⅞
Western Union 7 per Cent. 1st Mortgage	117,	123	—	— xd.
Do. 6 per Cent. Sterling Bonds	101,	104	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	⅝,	¾	—	— xd.
Oriental	¼,	⅜	—	—
United Telephone	11,	11½	11⅝	11½
United River Plate	4½,	5	—	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	2½,	2¾	—	—
Do. (fully paid)	3,	4	—	—
Swan	1¼,	1½	—	—
Maxim Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	36½,	37½	37½	37
India Rubber, Gutta Percha and Telegraph Works	21,	2	21½	21 1-16

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

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NOTES.

Not the least valuable part of the proceedings at the Society of Telegraph-Engineers last week was Mr. Charles Bright's well-timed criticism of Mr. Stallibrass's paper. Mr. Stallibrass rather overdid his advocacy of preliminary surveys for cable operations; and it was well for the meeting to be reminded by one who had evidently brought some practical considerations to bear on the subject that if it had had to wait for deep-sea surveying, deep-sea cable laying would never have been undertaken. No adequate soundings were made prior to 1879, yet most of the cables then submerged are still alive, and it would be hard to prove that the failure of those which have not survived has been due to inadequate surveys. To be of real practical utility the soundings must cover almost every inch of bottom, a case cited by Mr. Bright showing that even a very careful survey may overlook the existence of a configuration inimical to the safety of the cable.

A large section of our readers will be glad to observe that in this number we publish the first of a series of papers by Dr. Fleming on the theory of alternating currents. Dr. Fleming has undertaken, by dint of mechanical illustration and painstaking explanation of the difficulties which beset the subject, to bring the treatment within the grasp of the meanest (mathematical) capacity. To a certain extent the papers will take the form of an elucidation and a commentary upon the work of Mr. Thomas Blakesley on the same subject, which was originally published in these columns in the year 1885, but they will also include a large amount of original research of both a theoretical and an experimental character. We must add that, owing to Dr. Fleming's numerous engagements, the papers will perhaps appear at somewhat irregular intervals.

Elementary students, especially those who are interested in submarine telegraphy, will note with satisfaction that we this week commence a series of "Letters for Learners," by Mr. A. E. Kennelly, of the Eastern Telegraph Company, whose researches in the higher branches of cable testing are already widely known and appreciated.

In the matter of Ferranti *v.* Gaulard and Gibbs, we are now able to state on the best authority that the rumour to which we referred last week, and which stated that the matter had been settled out of court, is entirely without foundation.

On the whole there seems to be decided ground for encouragement in the aspect of the electrical engineering trades at the present time. The more important firms are, so far as our information extends, with very few exceptions, doing a fair business, and in some cases have quite as much work in hand as they are able to undertake. It is true that prices have been cut very low, and there is still in many cases far too much readiness to accept contracts on terms which it is difficult or impossible to account for on ordinary business principles. We have just heard on good authority that in a certain case, upon which we commented at the time, where the highest and lowest tenders stood in the ratio of something like 5 to 1, the contractor has already expended considerably more than *three* times the amount tendered for, and has not yet come to the end of his job. It would be interesting to learn the contractor's own views upon the affair, both first and last. Let us hope, however, that in this case *Experientia docet.*

Complaints of bad workmanship and inefficient engineering are still not infrequent. These invariably arise from cases where the work has been undertaken by men who have received no proper training either in the theory or practice of electrical engineering. We do not want, even in appearance, to single out any individual example for condemnation, but we happen to know of one case in particular in which a firm of self-styled "electrical engineers" consists of two partners, one of whom lately forsook a highly respectable but entirely non-technical calling—let us say the cats'-meat trade—while the other acquired his scientific knowledge and experience in the intervals of duty as—let us say a shoe-black. This illustration is but a slight travesty of the actual facts, while the people in question are doing an extensive business upon terms with which some of our best-known firms are quite unable, or at least unwilling, to compete. We are not in favour of drastic measures in these cases, even if such were possible; but in the light of facts like this (and we could multiply instances if necessary), is it to be wondered at that respectable business men should consider it highly desirable to take steps which may at least indirectly tend to mend these crying evils?

Turning to the brighter side of the subject with which we commenced the preceding note, it is satisfactory to observe the encouraging strides which are being taken in the department of transmission of power. Inquiries are numerous, and in one case we could name a leading firm will be able at the end of the present year to show a turnover in this branch of their business exceeding fourfold the amount done last year.

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Another firm, who are more closely identified with storage batteries, are also making a speciality of electrical hoists, and find inquiries plentiful. In a third case, a well-known contractor is laying out plans for a central station solely—or at any rate primarily—for the distribution of power. It has long appeared to us that there are many towns, and many parts of London, where such installations would, if properly laid out, be certain to prove remunerative.

READERS of Mr. Nursey's paper on Primary Batteries (in which it will be remembered the author allows the respective inventors to speak for themselves) will kindly note that, in order to economise space, the following sentence has been omitted from the catalogue of the merits of each battery:—"The light was remarkably steady and brilliant, and of good quality." *Mirabile dictu!*

THERE is at least one kind of primary battery which appears to be a great success for domestic purposes. On Monday last a whole page of the *Daily Telegraph* was appropriated to the advertisement of a certain electropathic belt, and if in this case, as in most others, the financial merits of the ware may be estimated by the money spent on advertising it, the article in question must be a very valuable property. Seeing that there are several competitors in the field, all equally profuse in their subsidies to the press and all equally lavish in their promises to the faithful, electro-pathology is a business which M. D'Humy and others might take up with advantage. The advantage which the medical battery possesses over the rest is that, although like some of them it appeals to faith, unlike them it cannot be rejected by reason. Everybody hopes that the numberless cures ascribed to its agency are genuine; but the beauty of it is that nobody can prove they are not. We advise the friends of primary batteries to seriously consider this means of employing their idle stock. If Electricity is Life, why not lay it on to every household, storing it in the place now occupied by the medicine cupboard, and charging at so much per head?

DYNAMO men should not miss the Note on an instructive break-down which will be found further on.

AMONGST the distinguished few who evidently bring to bear a sound scientific knowledge upon the problem of lighting by primary batteries, the designer of the particular form of chromic acid cell which is described in another column will take an honourable place. It was refreshing to listen to the candid and unasked-for confession that this cell does, after all the efforts of the inventor, still possess some internal resistance, that there is still some trifling amount of local action to be apprehended, and that it does not at present afford so economical a means of domestic illumination as gas. This is the sort of thing which gives one a returning gleam of confidence in the ultimate prospects of primary battery lighting. And we may add, moreover, that so far as our observation has gone we have formed a distinctly favourable opinion as to the merits of this particular cell—at least, for all cases in which a chromic acid solution is admissible.

MR. THOMAS BLAKESLEY'S brief reference (at the Physical Society's Meeting on Saturday) to the employment of condensers with alternating current apparatus may ultimately be found to cover a point of no small practical importance. Some eighteen months ago at Mr. Frank Nalder's laboratory, at Brentford, we had the pleasure of witnessing the experiment in question, when performed by Mr. Blakesley for the first time. An alternating current machine was connected up in series with two Siemens dynamometers and a resistance coil. Between the two dynamometers the circuit was bridged across by a condenser. Mr. Blakesley had predicted that with this arrangement the current passing through the armature of the machine would be less than that passing through the resistance coil. A very marked effect of this character was at once apparent on the dynamometers. This is not the place to go into the theory of the phenomenon, which is now pretty well understood; but it may be pointed out that the condenser counterbalances, as it were, the self-induction of the coil, and thus reduces the impedance of this portion of the circuit. We believe that this phenomena has been also independently discovered by Dr. Muirhead, and everyone will remember that in Mr. Sumpner's paper read before the Society of Telegraph-Engineers and Electricians in May last the combination of capacity with inductance was elaborately discussed. But this was twelve months later than the date of the experiment now described.

IN order to avail ourselves of the property of condensers referred to above in the practical application of alternating currents it would be necessary to find some simple and economical method of constructing a condenser of large capacity. There seems no reason to doubt that the problem can be solved in a very simple manner. Clerk Maxwell was, we believe, the first to call attention to the possibility of using what may be called voltameter-condensers with alternating currents, and Mr. Blakesley, Dr. Fleming, Prof. Silvanus Thompson (and possibly many others) have all suggested or discussed the idea; but we are not yet aware that any one has actually tried it. (This no doubt arises from the fact that alternating current machines are so rarely found in laboratories.) A voltameter condenser must consist of at least ($V \div 1{\cdot}4$) cells joined in series, where V is the maximum periodic E.M.F. at the terminals. The platinum plates may be of very small size, and the liquid pure water. Under these circumstances no current can flow, but the capacity of the series will be very great. The effect is, of course, due to the incipient decomposition of the molecules of the liquid, whose relative polar directions are reversed at each alternation of the current. The arrangement may be roughly compared to a series of elastic springs which are alternately compressed and allowed to expand, the springs being always fixed rigidly at one end and free at the other, and the end at which they are fixed undergoing alternate change. It may be hoped that we shall soon hear something further on this interesting subject.

CAPTAIN SHAW'S report just issued on the destruction by fire of the Exeter Theatre places among the foremost causes of the appalling loss of life the absence of any lighting arrangements independent of the stage. This is a point on which we

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have strenuously advocated reform ever since the fatal conflagration at the Opéra Comique.

It has never been our custom to make capital out of the mischances which dishearten the advocates of those forces that in various directions attempt to dispute the field with electricity. Our esteemed contemporaries, the *Gaseous Chronicle*, the *Coal Tar Gazette*, and the *Carburetted Hydrogen Calendar*, know this full well, and regard our silence with a similar gratitude. (We also at times remember an adage about "glass houses.") For once, however, we are moved to recapitulate in brief the story of a remarkable accident which occurred in the streets of Cincinnati to a tramcar on a cable line. A strand of the cable broke loose and one end wrapped around the gripper, so that the car could not be released from the cable. Another car was standing still a little way ahead, and with this the runaway car came into violent collision. The two cars tore along the crowded streets, and at length collided violently with a horse car at a crossing. All three cars were overturned, and the sudden jerk to the cable threw several more cars off the rails. Thirty or forty people were injured. While writing of tramcar accidents we may note that the story which we recently copied from a Philadelphia paper about a fatal accident to a horse from the breaking of an overhead wire belonging to the Van de Poele system has since been contradicted by the New York *Electrician*.

A good while ago we put the question to those whom it concerned, On what scientific principles can the alleged properties of a certain battery be accounted for? but no reply was vouchsafed. An independent correspondent now informs us that he has found the explanation of most of the phenomena connected with this remarkable invention, not in Clerk-Maxwell but in Thomas Carlyle. The people of this country, said the sage of Chelsea, number "twenty-seven millions, mostly fools." We feel sure our correspondent means by this that the inventor is *not* to be classed with the majority, whatever may be thought of his patrons.

While wishing all possible success to the Leamington Central Lighting Station, it is impossible to shut one's eyes to the fact that the promoters of the scheme have placed themselves in a position in which they must achieve either triumphant success or suffer disastrous failure. We are writing upon the assumption that the business is to be conducted upon ordinary commercial principles; and if it can be shown that a simple three-wire distribution can be made to pay its way in this country under a tariff of 4d. to 7d. per unit, then we shall be amongst the first and the most sincere in congratulating Messrs. Chamberlain and Hookham upon their achievement.

Milan.—The Victor Emmanuel Theatre at Milan has been supplied with an electric light installation.

Vienna.—It is reported that the Tramway Company of Vienna has entered into negotiations with an American company for the introduction of electric motors upon the whole of its lines.

Handbook on Accumulators.—Messrs. Whittaker and Co. will publish next week a third edition of Sir D. Salomons' little "Handbook on Accumulators." We learn that the book will appear in an entirely new and handy form, with illustrations in the text and much additional matter.

Proposed Telephone Cable between London and Paris.—According to the daily papers observations are being made on the French coast and in the Channel by French Government officials, with a view to laying down a new cable across the Channel, in order to establish telephonic communication between London and Paris.

Books Received.—We have to acknowledge the receipt of the fourth volume of the *Transactions* of the American Institute of Electrical Engineers, which contains the reports of six meetings held during the interval from June, 1886, to July, 1887.—We have also received a copy of "L'Electricité, Notions et Applications Usuelles," by M. Aug. Michaut.

Lecture on Electric Lighting at Newcastle-on-Tyne.—Mr. W. B. Sisling, electric superintendent of the Newcastle Exhibition, delivered a lecture on the subject of electric lighting in St. James Schoolroom, Bath-road, Newcastle, last week. The lecture was an especially interesting one, as Mr. Sisling was able to show in operation a Paris and Scott transformer and a couple of Mr. F. J. Rowan's electro-magnetic machine tools.

The Société Generale des Telephones. — The *Bulletin du Crédit*, a financial journal, published in Paris, says that owing to the constantly increasing business of the company the board of administration have decided to call up the balance of 125 francs per share. Up to the 27th October last the number of subscribers was returned as 7,589—namely, 5,271 in Paris, and 2,318 in the provinces. The capital of the company is 25,000,000 francs—say £1,000,000.

An Electrical Pilot Engine.—An Austrian lieutenant, named Giessle, of Brünn, is said to have developed an idea which is, perhaps, more strikingly original than practically useful. He proposes that every railway train should be preceded by an *avant-courier* in the shape of an electrical pilot engine—attached, we presume, by wires to the advancing train. We do not doubt that this *can* be done, but we shall be astonished if railway engineers will be at all thankful for the suggestion.

Sir William M'Arthur.—Many of our readers will learn with extreme regret that Sir William M'Arthur, who has been a Director of the Eastern Extension Telegraph Company for many years, expired under painful circumstances on Wednesday morning. The deceased gentleman, who was travelling by the Metropolitan Railway from Notting Hill Gate, about half-past ten o'clock, was taken suddenly ill when the train reached Bayswater, and died a few minutes after his removal at the Praed-street Station.

The Society of Telegraph-Engineers and Electricians.—A meeting of the above society will be held at 25, Great George-street, Westminster, on Thursday, November 24th, at 8 p.m. The following papers will be read:—(1) "On some Instruments for the Measurement of Electromotive Force and Electrical Power," by Dr. J. A. Fleming, M.A., Member, and C. H. Gimingham. (2) "Portable Voltmeters for measuring Alternating Potential Differences," by Profs. W. E. Ayrton, F.R.S., V.P., and John Perry, F.R.S., Member.

The Westinghouse "Automatic" Engine.—We note that the prospectus issued by the promoters of the Westinghouse Engine Company contains a list of over 150 of these engines employed in this country and in America for electric

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lighting. The Admiralty have ten Westinghouse engines in use. Many of these have been hitherto imported from America, the facilities for their manufacture in this country not being sufficient to meet the demand. The new company is therefore floated with the idea of undertaking the manufacture on a larger scale.

Bournemouth.—With reference to a *conversazione* of the Bournemouth Society of Natural Science, held at Ascham House on the 8th inst, the "Bournemouth Visitors' Directory" of the 12th says:—"Mr. Lynd fitted up twenty incandescent lamps, which were lighted by fourteen of the Electrical Power Storage Company's accumulators. These cells were charged at the Millwall Works, and sent down from London for use at the *conversazione*. The system of storage of electrical energy was explained to a number of gentlemen, who appeared to take an interest in electric lighting."

The Lighting of the Isthmian Club.—We were indebted to a member of the above club for a note in our last issue concerning the recent introduction of electric light, in which a portion of the work was credited to Messrs. Woodhouse and Rawson. A correspondent now informs us that this is inaccurate, and continues: "The brass fittings used in the billiard room and in some of the passages were supplied and fitted up by Messrs. Verity and Sons, but the fittings for by far the greater number of lights, which are constructed altogether of wrought iron and are exceedingly handsome, were made by Messrs. Starkie, Gardner and Co., and installed by the United Electrical Engineering Company."

The Ries "Combination" Conduit.—Mr. E. E. Ries, of Baltimore, proposes to kill two birds with one stone. He suggests—and, of course, patents—an arrangement in which in an electric railway on the "conduit" system the whole of the space on each side between the central conduit and the rails is utilised for telegraph, telephone, or electric lighting conductors. To this end the space in question is filled to the depth of 18in. or 2ft. with numerous paper tubes of different diameters, which are set in concrete. Manholes are provided at frequent intervals. The idea is that the tramway company should provide the conduits and let them out to the telephone or electric light companies.

The Electric Lighting of the Recent American Exhibition.—An error occurred in the note under this heading in our last issue. The engines used for driving the Thomson-Houston dynamos were three compound undertype engines, with boilers above, of 10 horse-power nominal, 30 horse-power nominal, and 50 horse-power nominal respectively, and a fixed compound engine with separate boilers of 60 horse-power nominal, making an aggregate of 150 nominal horse-power, which ought therefore to be capable of running up to about 450 indicated horse-power. There were 285 arc lamps in use, taking each 75 to ·8 horse-power, so that about 228 to 230 horse-power was actually used.

The Brussels-Paris Telephone Line.—MM. Manne, of Curheim, write us with regard to the report in the French journals (to which we referred in a recent issue) as to the destruction of a portion of the Brussels-Paris telephone line during the recent gales. MM. Manne are interested in the matter, inasmuch as they supplied the phosphor-bronze wire which is used as far as the Belgian frontier. They assure us that the only foundation for the report in question arose from the fact that the coping-stone to which the wire was attached at the Brussels Bourse (where the line terminates) was torn away and fell into the street, but even then the wire did not break. We are further told that not one phosphor-bronze wire in the Belgian telegraph service was broken during the gales. A letter from the Brussels Ministry of Posts and Telegraphs is also enclosed, confirming these statements. We are very pleased to note this satisfactory proof of the reliability of this class of wire.

An Extraordinary Mishap at a Central Lighting Station.—At a central lighting station in a certain town not far from London a very curious accident recently occurred which very nearly caused the entire breakdown of a series-wound high-tension dynamo on a circuit of 2,000 volts. In order to see whether a pole-piece was getting hot an attendant unwisely attempted to spit upon it. We say unwisely because, not being a Yankee he had not acquired the art of spitting straight, and missing the mark, the field coil received the full benefit. The machine in question is an elderly one, and possibly the coils wanted a new coat of varnish—anyhow, in a very few minutes the cotton covering commenced to char, and a small arc began to play across the wire. It wanted still an hour to the time when the machine should stop running. By dint, however, of incessant "dabbing" with a handful of asbestos the arc was kept within limits until the evening's work was over. It was then found that the insulation had been destroyed to the depth of four layers of wire. MORAL: This method of testing the temperature of pole-pieces requires some practice, and should only be undertaken by an expert.

Cancelling of the Bell Patent in Austria.—The efforts of the Telephone Company of Austria to get the Bell Patent cancelled have at last been successful. Their manager, Mr. R. Howard Krause, believed this possible from the commencement, and with the assistance of Mr. Otto Schaffler the company has been the means of securing free trade in telephones in Austria. The result of the decision of the Austrian Ministry of Commerce, and the Hungarian Ministry of Agriculture, Industry and Trade, dated October 28th, 1887, seems to be that all those clauses of Bell's Patent which refer to the telephone are cancelled, only those referring to the multiplex telegraphy being allowed to stand. Certain clauses were cancelled because the Telephone Company of Austria was able to prove prior publication, and others were cancelled because the company proved that they embodied scientific principles which, according to Austrian law, cannot be the proper subject of a patent. The Telephone Company is naturally very jubilant over its success, and is preparing for a large development of its enterprise.

Important Search-Light Experiments at Newcastle.—During the last fortnight of the life of the exhibition a search-light, constructed by Messrs. Clarke, Chapman, Parsons, and Co., was exhibited on the watchman's tower of the old Tyne Bridge, and created a great deal of interest in the district. The lamp took a current of 100 amperes at 60 volts, so that it was nominally a 24,000-candle light. On one evening an ambulance competition was held in the grounds, and the dais on which the competitors did their work was illuminated by the search-light; but the most interesting experiments with the light were carried out by Captain Oswin Bell. Between Newcastle and Tynemouth high land intervenes, so that signals cannot be flashed direct between the coast and Newcastle. Captain Bell wished to see whether signals flashed into the sky could be read across the higher land. Accordingly, men were stationed at North Shields, Tynemouth, and along the coast as far as Blyth. The evening was very unfavourable, as there was a haze near the ground, a clear sky, and a bright moon; but Morse signals could be read in the sky at all the stations. The maximum elevation of the light was about 150, but at Blyth it was best seen at a much

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lower elevation. The distance between the exhibition and Blyth in the straight line is about 11½ miles.

Telephone Apparatus and the Spanish Tariff.—The Spanish Customs journal, *El Eco de las Aduanas*, of Nov. 7th, publishes a royal order setting aside a decision of the Customs Arbitration Board respecting the application of the Customs tariff to imports of telephone apparatus. It would appear that a consignment of about 7cwt. (330 kilogs.) of telephone apparatus, made of fine wood with brass fittings, was presented at the Irun Custom-house, and declared under Section 180 of the tariff, which applies to "fine wood manufactured into furniture or other objects, turned, sculptured, polished and varnished," the duty upon which, for treaty nations, is at the rate of 13s. 6d. per cwt. (nearly). The declaration was refused, and Section 181 of the tariff was imposed, the goods being considered as "fine wood manufactured into the same articles, gilt; and those veneered with mother-of-pearl or other fine materials and designs of metal," &c., the duty upon which was, for treaty nations, no less than £2. 1s. per cwt. (very nearly). This decision was appealed against, and the royal order now issued sets forth that as the metal buttons attached are for the purpose of joining the wires and to permit the apparatus to work, and that as the apparatus is similar to electric bells, which have already been passed under Section 180, it is ordered that the telephone apparatus in question shall be admitted under the lower rate of Section 180 as in the first instance.

The Cost of Electric Light Fittings.—Mr. Nelson Haxell, of Haxell's Hotels, London and Brighton, writes as follows to the *Daily News*:—"Nothing prevents the immediate universality of house-to-house electricity and our happy deliverance from gas with its compound attendants of disease, dirt, villainous filthy smells, danger, and a price per thousand feet absolutely absurd at its present prime cost of production, but the absolutely prohibitory charges for what Hammond and Co. call 'the installation.' Could I only get installation at even a fair rate I would lay on the electric light in both my hotels immediately. Let us go into this. In my Brighton hotel I had arranged all costs of supply, wire and lamps—of which more anon—when they actually demanded of me an additional sum of £20 to give me unlimited supply, day and night, without which in my business it would be useless. In other words, not having the fear of competition before their eyes they insisted I should find £20 capital to enable me to be a good customer to them. So exit electric light for the present. Here in the Strand an electric company, beloved of Hammond and Co., have sent me in an estimate for installation amounting to £267. 10s. for wires and lamps, a rental of £15 per annum for fittings; one need not go into the calculation of the cost of silk-covered wire. . . . This, Sir, is a round unvarnished tale; and until electric lighting companies can see that it is to their interest to reduce them, these prohibitory charges will prevent the introduction of house-to-house electricity and the 'good-bye at the door' to gas, with all its dangers, dirt, and dearness."

Leeds.—On the proposal for the reappointment of the Electric Lighting Committee of the Leeds Corporation, Mr. E. Wilson spoke in opposition. He submitted that of the money granted to the committee for the provision of the electric light £3,965 had been squandered on a system of lighting which could have been got for half the money.—Alderman Emsley contended that there was nothing to show for the money which had been expended. He believed that £6,000 of the £10,000 granted had been spent.—Alderman Tatham reminded the council that when the committee was appointed electric lighting was in its infancy, and had been constantly undergoing improvement. He admitted that their electric installation could now be obtained at half the cost, but it could not have been set up for that amount when it was provided. He submitted that there had been no waste of money, and urged that the committee should be again appointed to watch the course of events.—Mr. Harland opposed the appointment of the committee.—Alderman Baker pointed out that a good deal of the money had been spent in preventing companies from coming into Leeds and pulling up the streets in order to provide electric lighting, and in obtaining information with reference to the best system. Then there were the costs in connection with the lawsuit which was commenced in reference to some part of their installation. At the same time it appeared to him that there was nothing now for a committee to do.—Alderman Spark pointed out that their scheme of electric lighting included the lighting of the new Fine Art Gallery, and if the committee was not reappointed that matter would fall into confusion.—Mr. Hardwick, chairman of the committee, having explained the course adopted by that body, and vindicated its action in not going on experimenting, the council voted on the question, with the result that the committee was reappointed.

Experiments on the Working Model of an Electric Boat.—Some interesting experiments were made at the Liverpool Exhibition by Messrs. Cox, Robinson and Co. on a working model of an electric boat, the object being to test its efficiency when in the water as compared with the power developed by the motor when running out of water. The model was seven feet in length by eleven inches beam, and eight inches in depth. It was propelled by a series-wound motor of the Siemens type, having a resistance of 6 ohms, and weighing 14lb., driven by five E.P.S. accumulators, whose capacity equalled 17 ampere hours; maximum safe discharge, 10 amperes. The total weight was 41lb., that of hull and fittings being 26lb. The motor was first allowed to run with the boat out of water. Tooth gearing was used between the motor and the screw-shaft, the ratio of the gearing being four to one. The results were as follows: Revolutions of motor, 1,910 per minute, with a current of 4·9 amperes. On placing the boat in the water the speed of the motor fell to 1,240, and the current rose to 7 amperes. The boat travelled at the rate of 64 yards per minute. This result being unsatisfactory, the motor was afterwards coupled direct to the shaft, the same screw and battery being used. The boat being taken out of the water, the revolutions were 2,100, and the current became 4·3 amperes. This showed an absorption of 6 watts, due to the gearing. On putting the boat in the water the revolutions fell to 760, the current rose to 8·4 amperes, while the speed of the boat was 129 yards per minute. This is a considerable improvement, when the increase of speed is compared with the increase in expenditure of power. The above data can be regarded as being very nearly correct—say within 5 per cent. A variable resistance was used in circuit for the manipulation of the speed. Messrs. Cox, Robinson and Co., point out that although a steam engine would develop more power from the same total weight in a boat of this size, the coal it would carry would not enable it to continue running for more than 35 minutes, whereas the accumulators would last for two hours without recharging. The fact that the motor fields were not saturated would admit of more cells being added to the batteries, and the output being increased thereby.

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NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

Both in hydro-dynamics and in electro-dynamics the condition of fluid flow or electric currents may be considered either in the *variable* or in the *steady* condition. In the former case the strength and direction of the electric currents or the fluid velocity is changing at every instant; in the latter case, it has settled down into a permanent form. The questions involved in dealing with the variable state present greater difficulties than do problems in steady flow, for the reason that the notions of *time* and *inertia* enter into these in a way in which they do not when that flow has reached a steady condition. We shall in these notes examine in an elementary manner some features of electrical flow when periodic, fluctuating, or variable. When a mass of water is in motion at any instant, a particle of water selected for examination has a particular velocity in a particular direction. This may be represented by a straight line drawn from that point representing its velocity in direction and magnitude. Similarly, if electricity is flowing through the mass of a conductor in any manner, it is possible at any point to draw a *vector* or line representing at that instant the direction and magnitude of the current at the point from which the line is drawn. Lines drawn in the mass of a conductor such that the flow at every point is along or tangential to these lines are called *stream lines*. If a surface is supposed described in the mass of the conductor everywhere perpendicular or orthogonal to the stream lines, such a surface is called an equipotential surface. Let it be supposed that such a surface is drawn in the mass of a conductor through which a current is flowing.

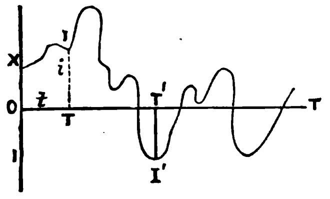

FIG. 1.

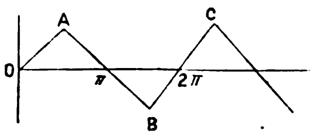

FIG. 4.

In the first place, let us make the supposition that the flow has reached a steady condition. The stream lines are then fixed. Let any area be drawn on the equipotential surface, and let it be divided up into units of area. If the quantity of electricity flowing through each unit of area is the same, and if, moreover, it is the same for each unit during each succeeding instant of time, the current is said to be steady and to be uniformly distributed. The quantity flowing per unit of time through any area is the numerical measure of the strength of current *at* that section of the conductor, and the quantity flowing per unit of time through a unit of area is the measure of the density of current over that unit of area. If the distribution of current and strength is not uniform we can only express them at any time and place by calling to aid the language of the differential calculus. If $d\,s$ be a small area described on an equipotential surface, and if $d\,q$ be the quantity of electricity which flows in a small time $d\,t$ through that area $d\,s$, then if i is the strength of the current and d the density of current at the centre of that small area, in the limit when the area becomes vanishingly small

$$i = \frac{dq}{d\,t} \text{ and } d = \frac{i}{d\,s}.$$

To fix our ideas, let us now suppose the flow to take place through a cylindrical conductor, such as a wire, in which at positions sufficiently remote from the ends the stream lines will be parallel to the axis of the wire and the equipotential surfaces perpendicular to it.

Consider any one section, and let the flow across this section be variable both in strength and direction—that is to say, let it vary in the quantity of electricity which flows across that section in each succeeding instant, and let the flow be first one way and then the other, varying in any manner, however irregular. We can now represent graphically the state of things as regards electric flow at that section by means of a *current curve*. Take a horizontal line (Fig. 1) to represent the uniform flow of time. At every instant let an ordinate be drawn to this line, representing the strength of current flowing that section, and let it be drawn above + or below –, according as the direction of the flow is to the right or to the left. Accordingly, if time begins to reckon from O, after the lapse of a time O T the current is +ve, and is represented by a line T I. After the lapse of a time O T′, the current is –ve, and is represented in strength by a line T′ I′.

This curve may be called the current curve, and it is obviously a single-valued function—that is to say, corresponding to a given time the current can only have one value. The curve can never cut itself or double back.

In Fig. 2 is represented a curve such that there are five different values of the ordinate of the curve corresponding to one value of the abscissa $o\,x$. In Fig. 3 is represented a single valued function, such that there is only one value of the ordinate $x\,y$, corresponding to a given value of abscissa $o\,x$.

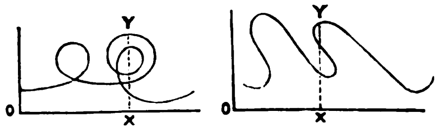

FIG. 2.
Multiple valued functions.

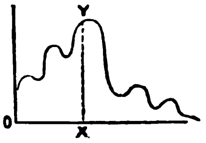

FIG. 3.
Single valued function.

Fourier was the first who enunciated the remarkable mathematical theorem now known as "Fourier's theorem." Generally stated it is as follows:—Any single valued function can be expressed as the sum of a series of terms, each one of which is the sine or cosine of an angle multiplied by a constant. Stated in other words, this amounts to saying that the equation to any such curve can be found in the form of an infinite series of terms, each one of which is the sine or cosine of an angle multiplied by a constant term. The most remarkable part of Fourier's method is its power to represent in this form the equation of lines made up of pieces of straight lines. Take the case of a line O A B C, &c. (Fig. 4), made up of lines inclined at angles of 60deg., the length of each line being $2\,\pi$ units of length. Then it can be shown that the equation to the broken line O A B C, &c., is the series

$$\frac{4}{\pi}\left\{ \sin x - \frac{1}{9} \sin 3\,x + \frac{1}{25} \sin 5\,x - \&c. \right\}$$

or is an expression formed of the sum of a series of terms, each one of which is the sine of an angle multiplied by a constant term. There is another mode of viewing this analysis which makes it especially applicable in dealing with many physical problems. Suppose a circular disc (Fig. 5), with a pin at its centre, O, and pivoted so as to revolve round an excentric point, C. Let a T bar moving in guides and having a slot in the cross-piece be so fixed that the centre pin O is constrained to move in the slot. Furthermore let the point C round which the disc moves be fixed to some support in the line of the bar A B produced. If the excentric is compelled to move round C, the extremity of the bar A will move backwards and forwards with a motion called a simple harmonic motion.

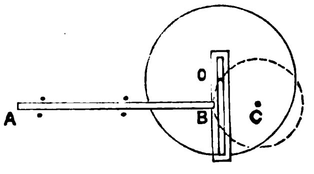

FIG. 5.

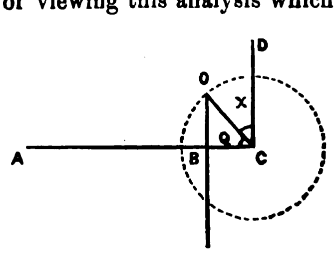

FIG. 6.

For it is clear the point O (Fig. 6) is compelled to move in a circle round C as a centre, and hence the distance of the point A from C at any instant is the length of the bar A B *plus* the length B C, which is the projector of O C on the line A C. The point B therefore executes a simple vibration to and fro along

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the line A C as O moves round, and the point A imitates the motion of B. If the angle O C D is called x and the radius O C r, then the length B C is $r \sin x$, and the displacement of A at any instant from its mean or middle position has the same value. The motion of A is called a simple harmonic motion, and the above excentric and T bar is a mechanical device for compelling a point to describe a simple harmonic motion (abbreviated into S. H. M.). If such an harmonic motion be executed by point A (Fig. 7) whilst at the same time a strip of paper, S S′, is caused to move uniformly in a direction perpendicularly to the line A B, a tracing point fixed to A will describe on the paper a curve such that the ordinate A Y is proportional to the sine of the abscissa X Y, or the equation to the curve will be of the form $y = a \sin x$, a being some constant.

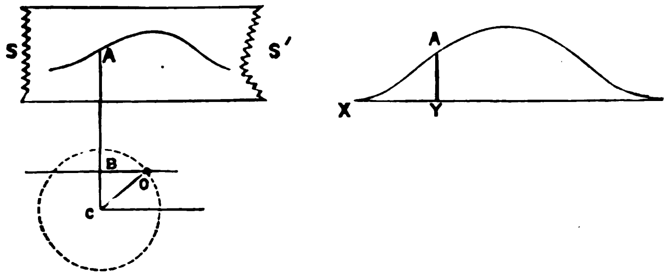

Fig. 7.

By combining together two similar pieces of mechanism it is possible to construct a machine which can add together graphically two simple harmonic motions in the same line, but of which the phase angles x are different, and the amplitudes a also. This can be accomplished in the following manner:—

Let a cord pass over four pulleys (Fig. 8), two of which, F_1 F_2, are fixed in space, and two, M_1 M_2, can be made to rise and fall in vertical lines with a simple harmonic motion. If the cord has one end, B, fixed and the other end, A, free, it is easy to see that if either the pulley M_1 or M_2 rises and falls along a vertical line and the cord is just kept tight, the free end A will be displaced by an amount equal to twice the displacement of M_1 or M_2, and as M_1 or M_2 moves up and down with a S.H.M., the free end of A will also execute similar vibrations. If M_1

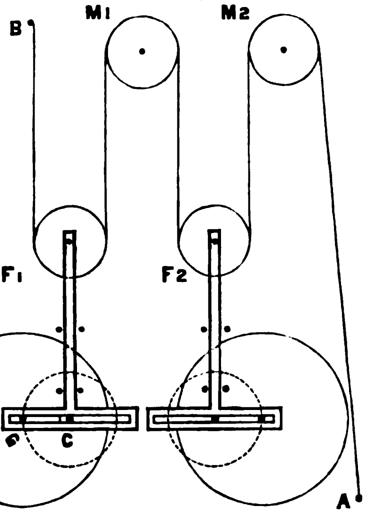

Fig. 8.

and M_2 move together the displacement of A at any instant is proportional to the sum of the displacements of M_1 and M_2. By providing the end A with a tracing point and moving under it uniformly a sheet of paper in a direction perpendicular to the direction of motion of A, it will describe a curve, of which the equation will be of the form

$$y = a \sin x + a' \sin x',$$

a and a' being the amplitudes, and x x' the phase angles of the two motions of M_1 and M_2 respectively. This apparatus, or one of similar principle, has been devised and employed by Sir W. Thomson in his tide gauge analyser. It will be evident from the foregoing explanation that a machine can be constructed capable of causing a tracing point to move to and fro across a uniformly flowing sheet of paper, with a motion compounded of a number of simple harmonic motions of different amplitude and phase taking place in the same straight line.

If, then, any single valued function is graphically represented —that is to say, any such curve as in Fig. 1—we see that this curve may be described by a point which moves horizontally with a uniform velocity, whilst at the same time it executes in a vertical direction a movement which is the sum of a number of simple harmonic motions superimposed upon one another.

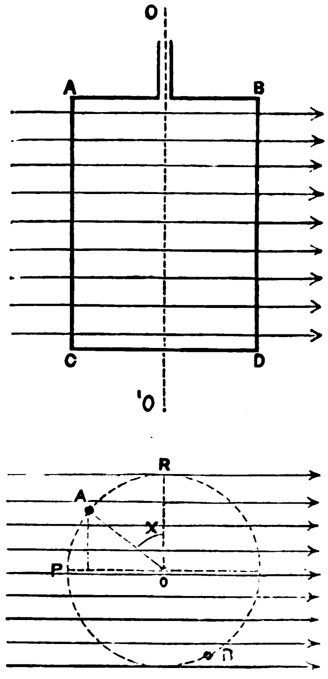

Fig. 9.

The combination of these two rectangular motions causes the point to describe the curve considered.

Fourier's theorem leads to many physical conclusions of great importance. In acoustics it shows, for instance, that however complicated may be the motion of an air particle in a mass of air through which sound waves are being transmitted, it can be resolved into the sum of a series of motions such as would be produced by the action of tuning forks, each of which gives rise to a motion in the air particles of the nature of a simple harmonic vibration. Helmholtz actually realised this in his synthesis of vowel sounds. We can in a similar manner synthesize by the superposition of simple harmonic electric currents any form of variable current, however complicated.

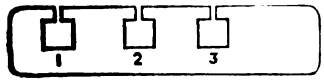

Fig. 10.

Let A B C D (Fig. 9) be a rectangular frame conductor, able to revolve round a vertical axis O O′ in a uniform magnetic field. The adjacent figure represents the same in plan. If the frame revolve round the axis O O′ the total electromotive force acting round the circuit is numerically the same as the time rate of change of magnetic induction through the circuit. If H is the field strength, l the length of the side, A C and k the length of the side C D, and x the angle which at any instant the plane of the frame makes with a plane drawn at right angles to the lines of the field, then the magnetic induction through the frame is the product of H, and the apparent size of the frame, as seen along the direction of the lines of the field, or is equal to $H l k \cos x$.

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If the area of the frame is A, the magnetic induction is H A cos x. Hence the effective electromotive force acting to produce a current in the circuit is

$$\frac{d\,(\mathrm{H\,A}\cos x)}{d\,t} = \mathrm{H\,A}\sin x\frac{d\,x}{d\,t}.$$

If the angular velocity remains constant, the effective electromotive force will be simply proportional at any instant to the sine of the angular displacement of the frame from its initial position. Hence, such a frame produces a simple sine variation of electromotive force. Let a series of such sine inductors be joined up on one circuit (Fig. 10), each capable of being regulated as to angular velocity, and imagine these to revolve in magnetic-fields of equal strength. If the sine inductors are originally set with the plane of their frames at certain different but fixed angles to the planes at right angles to the fields of force in which they revolve, they must be supposed to maintain these relative positions during their revolution. Accordingly the effective electromotive force in the circuit, when they are all joined up in series and set revolving, is represented by a function

$$e = \mathrm{A}\sin x + \mathrm{A}'\sin x' + \mathrm{A}''\sin x'' + \&c.;$$

and by Fourier's theorem any possible periodic variation of e which, graphically described, is a single valued function can be produced by suitable values of the constants and phase angles.

The converse of the above is also true. Let there be any alternate current machine producing in a circuit an electromotive force, and therefore a current varying periodically according to any law. This kind or form of current could be exactly imitated by removing the given machine and substituting a series of sine inductors coupled in series and arranged so as to each produce a simple sine varying E.M.F., the respective sine currents having different phases and amplitudes, but being superimposed upon one another.

LETTERS FOR LEARNERS.

By A. E. Kennelly, Electrician, Eastern Telegraph Company.

CHAPTER I.—The Nature and Sources of Electricity.

The Galvanic Battery.

1. Notwithstanding the numerous applications of electricity to the most varied purposes, our knowledge of its nature remains of the most scanty description. In the earlier stages of investigation it was supposed to have a material existence in the form of an extremely attenuated fluid that could readily permeate conducting substances, but which found obstruction in passing through non-conductors; in the same way that liquid might pass freely through fibrous material, but be completely arrested by a densely solid barrier. Hence the terms "Electric Fluid," "Current," &c., which are still retained, not only on account of their widespread acceptation at a time when their application was more accredited, but also for the convenience with which they serve to connect our ideas in dealing with the more intricate conceptions of modern theory. There is, as we shall see, considerable analogy between the laws of the flow of water and the laws of the transmission of electricity; but in employing the terms suggesting fluids it is necessary to remember that they are only convenient symbols by which we represent and express a totally different class of phenomena.

2. It is now generally agreed that electricity is altogether immaterial in its nature, but is an inherent property of matter, through the medium of which, as with heat, gravitation, or chemical affinity, matter may acquire energy and exhibit force. This conclusion is supported by a variety of considerations. For example, if electricity were matter we should expect it to exert gravitation like all other known forms of matter, but no one has ever been able to detect any increase in the weight of a condenser after charging it. On the other hand, every evidence of the presence of electricity, since its very first recorded discovery by Thales, in the attractive power of rubbed amber, has been, and is, through some manifestation of force; while it is always found that the production of a certain quantity of electric force requires the expenditure of a corresponding quantity of energy in some other form. Thus, to obtain electricity from a frictional machine or a dynamo, we have to turn the handle of the one or the armature of the other, and if we leave out of consideration the energy wasted in friction and heat, the power of the electricity produced will be the exact counterpart of the power mechanically expended in the turning process.

3. When we obtain electricity from a battery, however, we expend no power in direct mechanical action, but we find zinc and other chemicals consumed. In this case it is chemical force and energy of combination which is expended. The zinc combines with the oxygen of the water in the cells, and is thus practically burnt; while for every grain weight of zinc thus usefully consumed a corresponding definite quantity of electric power is generated.

4. In different kinds of batteries the same weight of zinc usefully consumed may yield very different quantities of electrical energy, owing to the fact that the chemical affinity of the elements varies in different combinations of metals and solutions. The greater the resulting chemical affinity, the greater will be the energy expended in the union of a given quantity of the elements, and the greater the corresponding quantity of electrical energy developed—in other words, the greater the *electromotive force* of the cell. This electromotive force is conveniently expressed by the abbreviation E.M.F., and is practically measured in definite units, called *volts*.

5. A good type of galvanic cell should therefore fulfil the following requirements :—

(1.) The total useful chemical affinity, and thus the E.M F., should be as great as possible and constant under all rates of current supply.

(2.) None of this energy of affinity should waste itself in forming combinations while the cell remains idle. In other words, there should be no loss of material by local action.

(3.) The cell should offer in its own elements and solutions as little obstruction as possible to the liberation of the electricity it develops—that is to say, its internal resistance should be as low as possible.

(4.) The materials for its consumption should be cheap and readily obtainable.

(5.) The cell should require no inspection or supervision to keep it in good order until all the energy of its chemical affinities is exhausted.

(6.) The form and dimensions of the cell should be convenient, and no noxious chemical products should be formed in it by action.

No battery fulfils all these conditions with any degree of completeness, but we may discuss one or two of the more general forms and compare them by this standard.

6. The simplest and typical form of cell consists of a plate of zinc and a plate of copper plunged in water. As pure water is not a very good conductor, it may with advantage be acidulated, or rendered saline by the addition of common salt. No electrical action takes place if the metals are pure as long as the plates are kept apart, but the moment that they are brought into contact, either in the water or above its surface, a current will immediately be generated. It is not necessary that the plates themselves should be made to touch each other, for the wire F G H (Fig. 1), usually copper connecting wire, may be considered as an extension of the copper plate, making contact with the zinc at the point H.

7. The contact of these two metals at the point H is said to establish a *difference of potential*, and to be the primary source of the E.M.F., although the explanation of this observed fact cannot be said to be known. Difference of potential is with electricity precisely like what difference of level is with water; and just as water flows in virtue of difference of level from the higher to the lower, and the greater the difference of level the greater the force or head of water, so electricity flows in virtue of difference of potential from the point of higher to the point of lower, and the greater this difference of potential the

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greater the electromotive force. In fact, difference of potential constitutes electromotive force.

8. The difference of potential set up by the contact of the copper wire with the zinc plate at H (Fig. 1) causes the zinc plate to become positive and the copper wire negative; in other words, the zinc takes the higher potential and the copper wire the lower, and an electromotive force is thus determined generating a current from the zinc plate to the copper wire. There are obviously two paths by which this current from B can reach H—one direct across the junction A, the other circuitous through the water, copper plate, and wire, B E F G. The current is prevented by the E.M.F. itself from taking the direct path across the surface of contact, and is therefore compelled to take the second and longer route. It is therefore important to notice that the zinc plate, being positive to the copper wire as regards the junction H, is usually spoken of as the *positive element*, and hence the copper as the *negative element* of the cell; while externally, because the current is flowing in the wire F G H from F to G, the potential at F, though lower than that at B or E, is higher than that at H, and is therefore positive relatively to H. Consequently, on cutting the wire at G, the portions H G on the zinc and F G on the copper are called the *poles* of the cell, and F G being positive to H G is called the positive pole. So that, while the zinc is internally the positive element, the copper is externally the positive pole.

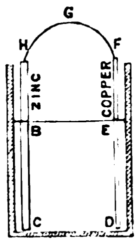

Fig. 1.

9. If the difference of potential due to establishing contact at H were temporary and unsustained, the current flowing from B round to H would re-establish equilibrium and cease, just as the flow of water from a higher to a lower level tends to equalise the level; but it is generally considered that the current having once started is maintained by the chemical energy of the materials in the cell. Thus in our typical case represented in Fig. 1, after the current has commenced to flow, bubbles of gas will be seen to form on the copper plate, and to rise to the surface of the water. The water is being decomposed into its constituents, oxygen and hydrogen, the oxygen attacking the zinc and uniting chemically with it, forming a coating of zinc oxide on its surface; while the hydrogen, not being able to form any chemical combination, forms in bubbles on the surface of the copper plate, these bubbles rising to the surface of the water as their buoyancy overcomes their attraction to the metal. If the water has been previously acidulated by the addition of a little sulphuric acid, the insoluble coating of oxide on the zinc plate is converted by the acid into sulphate of zinc, which, being soluble, disappears into the water, leaving the fresh surface of the zinc free. Thus in the action of the cell we find that the zinc plate is gradually consumed and loses weight, sulphate of zinc accumulates in the solution, the copper plate undergoes no change, but bubbles of hydrogen rise on its surface.

10. Such a cell would fairly satisfy all the requirements specified above except the first two; in fact, this was the original form of the galvanic cell, and the ancestor of all the numerous types in modern use. Its great weak point lies in its low and variable E.M.F., for the hydrogen bubbles in contact with the copper plate set up a counter E.M.F., opposing the current maintained by the original E.M.F. due to the contact of the zinc and copper. This phenomenon of gaseous contact and counter E.M.F. is commonly called *polarisation*, and the amount of polarisation varies with the quantity of hydrogen in contact; consequently, the resultant E.M.F. is very variable. The first attempt to overcome this difficulty was roughening the surface of the copper plate, so that the bubbles of gas were more quickly liberated upwards, and thus the limits of the variation in the E.M.F. were kept more confined. The early Smee cells were of this nature, but it was not until the invention of the Daniell cell that any approach to constancy of E.M.F. was arrived at.

THE PROPOSED ASSOCIATION OF ELECTRICAL ENGINEERS.

A large number of replies to our recent circular have been received, but, as they continue to reach us by every post, we postpone until next week an analysis of the contents.

ELECTRIC TRACTION ON THE WEST METROPOLITAN TRAMWAY.

We have recently visited the West Metropolitan Tramway Company's depôt at Richmond to inspect a new self-contained electric tramcar. This car presents no features of especial novelty, but we may congratulate the engineer on the workmanlike manner in which the general details are carried out. The car is of the ordinary two-horse type with outside seats, with the carriage raised somewhat so as to make room for the motor and gearing beneath the flooring. The rolling wheels are thus larger than usual, being 30in. in diameter. The motor is an ordinary Siemens horizontal machine, with an 8in. armature. Two sets of brushes are used, one for running in each direction. They are shifted by levers worked from either end of the car. The motion seems to be very easy and quite positive—a matter of no little importance. The motor and gearing are carried on an iron framing bolted to the sole bars of the under carriage. The gearing is double and is of the Julien type. The first transmission is made by a cotton and silk rope about $\frac{3}{8}$in. in diameter, which works in grooved wheels. The tension of this rope is adjusted by an idle pulley. The second transmission consists of a chain and sprocket wheels running in an oil bath. The gearing runs nearly noiselessly, and appears to work well, although it is perhaps doubtful whether the rope will be entirely free from slip. The accumulators are placed, as usual, under the seats; they are in trays of twelve cells each, four trays being used on either side of the car. This gives 96 cells. Each cell consists of a vulcanite box, open at the top, and contains 15 plates. These accumulators are by M. Philippart, and in the absence of any data as to their performance we may say that they certainly looked very healthy, and showed no signs of buckling or sulphating. The grid is of the E.P.S. type, as regards outside appearances at any rate. In each tray the twelve cells are coupled in series, and the end terminals are joined severally to two metal strips securely fastened to the bottoms. They are placed in the car on brass-capped runners, so that the act of putting in a tray makes electrical connection with the cells in it. These runners are joined by cables to a Julien commutating switch at either end of the platform, and by rotating a wheel on the top of this switch the cells can be made into combinations—1st, all in series; 2nd, two in series and two in parallel; 3rd, four in parallel. These arrangements give three different E.M.F.'s, 192, 96, and 48 volts respectively, and are used according to the speed required. An efficient hand brake is provided. The line between Richmond and Kew is very level and well laid, and should not have a tractive resistance of more than 30lb. per ton in an ordinary way. The difficulties to be met here are very light.

Electrical traction does not seem to be making much progress in London, though the matter is now certainly beyond the experimental stage. We shall be glad to hear that the West Metropolitan Company see their way to convert their plant. The present series of experiments are being carried out under the direction of Messrs. Christopher James and Co., engineers, of Laurence Pountney-hill, E.C.

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THE GOVERNMENT AND THE CHANNEL CABLES.

With much circumstantiality and a great parade of authenticity the *Central News* published on three succeeding days last week intelligence relating to the negotiations then going on between the French Government, the Submarine Telegraph Company, and the British Post Office, which seems to have been received by the Press and the public of this country as something of considerable importance. In reality the gist of the whole matter was contained in the opening sentence of its communication on Thursday, when the *Central News* announced that "the Government have resolved to keep under their direct control all telegraphic cables between Great Britain and France, Holland, Belgium and Germany as soon as the present concessions have expired." Since the taking of Holland by the Dutch, perhaps no piece of news in modern times has been more superfluous than this. That the British Government had resolved on that course has been known for many years past. Whether they will be able to act on their resolution is quite another matter, and one on which the omniscient news agency throws very little light. We are told that in respect to France a difficulty has arisen because the Submarine Telegraph Company have obtained the consent of the Government of that country to an extension of their concession for a further period of fifteen years; and it is intimated that the British POSTMASTER-GENERAL has vetoed the arrangement, or, to be more exact, has declined to be a party to the renewal. Probably nobody expected that he would be a party to it; what remained in doubt was that his veto will be effectual, or that his not being a party to the arrangement would prevent its being carried out, a doubt which the information furnished by the *Central News* has not in the least cleared up.

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This essential feature in the case is rendered not less obscure by Sir ARTHUR BLACKWOOD'S disclaimer, which in due course, like all official denials, appeared two days later, when the *Central News* had delivered its budget. The POSTMASTER-GENERAL directs him to say that the statements which had recently appeared in the Press were entirely unauthorised, and that the information conveyed was in many particulars inaccurate and misleading. On this we may remark that all such statements usually are inaccurate and misleading, whether authorised or not, the object of their publication being generally to give a bias to public opinion, and a consequent fillip to negotiations still pending. We have no reason to doubt that the news agency responsible for these statements had them from "the highest official sources"—a discount being allowed on the superlative. Indeed, the communication betrays in several particulars an official origin, and could hardly have been evolved from the inner consciousness of the *Central News*, though a great deal of amplification and rash conjecture have been obviously permitted in the editing. The *Central News* sticks to its guns; and naturally does not reveal the source, whether highest or lowest, of its inspiration. The ball has been set rolling; and from the brief now furnished by this enterprising agency in the case of the POSTMASTER-GENERAL *versus* the Submarine Telegraph Company and the French Government, doubtless many powerful discourses will be delivered when the subject is riper for discussion. There is no immediate hurry, however. The Company's concession does not expire until the year after next, and meanwhile we may hope that some friendly arrangement may be arrived at.

Nevertheless, we cannot believe that the statements which have now obtained publicity are calculated to pave the way for an amicable settlement. Some of them at least have an opposite tendency. The lofty, dictatorial tone, the insular and narrow conception of the situation, and the patronising spirit with which the Post Office is credited in offering to buy the Company's cables at "an electrician's valuation," but refusing anything for the "goodwill," are not exactly the methods of good diplomacy when something is risked by neglecting them. And that there is some risk seems to us undeniable. The facts of the case appear to be that the Submarine Telegraph Company, which has held an exclusive concession for English cables on the French coast since 1851, has obtained a promise of renewal for another term of years, but that the promise has not yet been confirmed by the French Government; and that the English Government are doing their utmost to prevent its confirmation. There is really nothing to be said against any of the parties to this triangular duel. The Company is entitled to get what it can, the French Government to give what it pleases, and the English to checkmate both. But it must not be supposed that the final settlement rests with any one of the parties—at least, we shall be greatly surprised if it does; and if the French Government, with its client, the Cable Company, chooses to be obdurate, things may be made unpleasant all round. If rumour speaks truly, the relations between the British Government and the Submarine Company have not been maintained on the most friendly footing, whilst those with the powers on the other side of the Channel have always been cordial. We have ourselves to blame, therefore, if the Channel Cables, fighting for their very existence, have sought safety in the good offices of a rival Power.

That our French rivals should have an influential voice in deciding this question seems to be quite overlooked in England. The cables land on the French coast as well as on the English, and the terms on which they will remain are surely matters for the French to decide. France shares with us the distinction of establishing these cables, the first experiments in submarine cable laying; and a considerable amount of French capital was embarked in the venture. We are not able to say how much is still retained in French hands; but a large proportion of the Company's stock consists of French scrip, and its French holders will naturally ask their own Government to protect their interests. Even from an English point of view, which has latterly assumed an attitude of antagonism to monopolies, the expiration of a monopoly does not involve the extinction of its business. Yet the absolute extinction of this cable business is accepted by the *Central News* and its informant as a matter of course, and the Submarine Telegraph Company as if it were as dead as Queen ANNE. Unless, however, the British POSTMASTER-GENERAL is prepared to drag up the shore ends of the Company's cables, or to put an embargo on all telegrams travelling over them, we do not exactly see how the Company can be prevented carrying on their business as before. And assuredly if the French Government were to decline to give him permission, the English POSTMASTER-GENERAL cannot land any opposition cables of his own on French soil.

We are playfully reminded in the second day's edition of the *Central News* programme that "although the Post Office declines to pay anything for the goodwill, the Submarine Telegraph Company will be able to pay its shareholders par value for their stock, as the Company has a substantial reserve fund." It happens, however, that the compulsory purchase clauses which find a place in modern legislation—generally to the suppression of all enterprise—were wholly unknown when the French concession was granted, and it is not competent for us to apply them retrospectively to a company simply because we want to get possession of its property. Not even the bribe of a "special reduced rate for Press messages" foreshadowed by the *Central News* would, we venture to think, induce the Press of this country to back up any of the high-handed measures we have just adverted to. For our part we do not suspect the Post Office of entertaining them. If it succeed in persuading the French Government on international grounds to waive its right to grant a further concession, the Post Office will be confronted by the Company alone, and the question will then arise: Are we to compete with each other, or are we to unite? That, so far as the facts at present known enable us to judge, is the simple issue. For the Company, the question is a grave one; but it is hardly less so for the British Government: and this being the case, we trust that the parties will approach each other in a conciliatory spirit. It is true that the Company have had little ground to expect that the exclusive rights they have enjoyed so long would be renewed; but, on the other hand, the British Government have had no right to assume that they would step into the expiring monopoly without paying something for it. As Englishmen, we should like to see these cables entirely in English hands; but as men of business we hope they may be acquired on terms fair and honourable to all concerned.

THE BREAKDOWN OF THE BOILERS AT THE VIENNA OPERA INSTALLATION.

The correspondents of the daily papers have given various versions of the reasons which have led to the stoppage of the Vienna Opera installation, but we have ascertained that the statement which attributes the failure to the boilers is substantially correct, the truth being that at the express wish of the local authorities the boilers were furnished by an Austrian firm. It is true that many boilers of similar type are at work in all parts of the world; but these are mostly of English manufacture. It appears that in this case both material and workmanship were of inferior quality. The following addi-

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tional particulars from the *Daily Chronicle* are also substantially correct:—

"The local authorities have condemned the boilers and insisted upon their being placed under repair. The company, on the other hand, declare that this step was not at all necessary, as the boilers could have been easily replaced while under repair. The loss entailed upon them is very great, as they have to pay a penalty of 3,000 florins a night for any interruption of the lighting arrangements, and this is not the first time the penalty has been imposed, as on a former occasion they had to pay a total penalty of 32,000 florins. Pending the repair of the boilers it is probable that a temporary central station will be established, naturally at the expense of the company, which is endeavouring to obtain permission to put up the necessary boilers, provisionally, in the Schencken strasse, close to the central station."

The Times correspondent says:—

"The Opera is likely to remain closed for some days, as an official committee of inspectors decided this morning that electric lighting should no more be furnished from the existing boilers at the central station. As already reported, these boilers of Austrian make have proved quite inadequate for the work required of them. There are few theatres in Vienna, so that the closing of the Opera is sharply felt by the public; but the ultimate result of this little misfortune will probably be greater circumspection on the part of the authorities in meddling with foreign companies undertaking public works which the authorities cannot accomplish for themselves."

ELECTRICAL PUMPING PLANT AT ST. JOHN'S COLLIERY, NORMANTON.

A very interesting example of the electrical transmission of power has recently been carried out by Messrs. Immisch and Co. at St. John's Colliery, near Normanton, where a dynamo and motor are now at work raising 39 gallons of water per minute through a head of 530ft., amounting to a theoretical duty of 207,900 foot-pounds, or 6·3 horse-power. We referred briefly to this installation on the 2nd September, but we are now indebted to Messrs. Immisch for the following detailed description of the installation, together with the accompanying indicator diagrams.

Work Done.	Speed of engine.	Volts on dynamo	Av. amps. given out by dynamo.	E. H.-P. given out by dynamo.	Work done in cylinder of engine.	Loss in cables res 29 ohms, 800 yards, 19/16.
Pumps delivering 39 gallons per minute.	86	171 173·5	47·5 47·5	10·9 11	14·2	·88 h.-p.
Pumps running with the suction clack lids off and the column empty.	86	134 128 127	28 28 26	5 4·82 4·45	6·3	·305 h.-p. ·305 h.-p. ·265 h.-p.
Motor and first motion shaft only.	88 86	111 105	20 20	2·96 2·8	4·8	·156 h.-p.
Dynamo only, running on open circuit.	86	0	0	0	1·715	0

Efficiency per cent. with full load $\frac{6\cdot3}{14\cdot2} = 44\cdot4$.

A single cylinder horizontal engine was used. The bore was 14in. and the stroke 15in. The steam pressure was varied by a reducing valve according to the work required.

This engine was an old girder engine. During the test it was found that the slide valve nuts had shifted on the bottom end. The diagrams are thus defective, since the steam was admitted too late and cut off too soon on the bottom end. This must have lowered the efficiency of the engine to some extent, and of course is against the net efficiency of the system. The power required to overcome the friction of the engine and dynamo without any load was 1·715 horse-power.

Both dynamo and motor are of the well-known Immisch type, and need no detailed description.

The motor ran at a speed of about 650 revolutions per minute during the test, the pumps making 8 revolutions.

The gearing consisted of three transmissions. The first a 10in. cotton belt, the second a mortised pinion gearing into a cast-iron wheel, and the third a cast-iron pinion and a wheel on the crank shaft of the pumps. This complex system for reducing the speed of the motor was, of course, not originally designed so, but circumstances made it convenient to use gearing in this manner.

The pumps were made by Messrs. Bradley and Co., of Wakefield, to the design of Mr. Brown, the engineer at the colliery. They consisted of two separate differential pumps. Each had one 6in. ram and one 4½in. ram. They were coupled by cross heads and connecting rods to the main shafts, with the cranks at right angles.

The suction was only made by the 6in. rams, but all the rams delivered water into the column; there were thus two suctions and four deliveries per revolution of the crank shaft, the pump being equivalent to a four-throw pump with 4½in. rams.

The division of the work done by the large rams was not by any means equal. Though to casual inspection the work done throughout a revolution was constant, an ammeter in circuit with the motor showed considerable fluctuations of current at regular periods. The difference of load thus experienced was as much as 25 per cent., and caused at first some trouble by heating the armature and pole-pieces, if the average current exceeded 50 amperes.

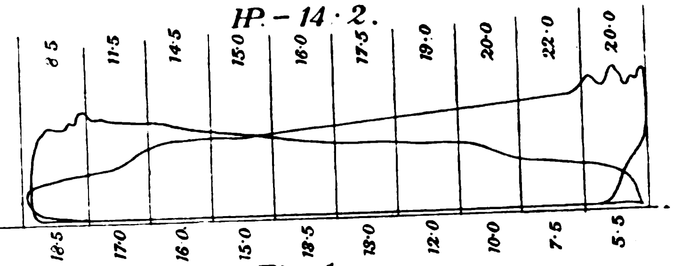

Fig 1.

Pumps delivering 39 gallons per minute.

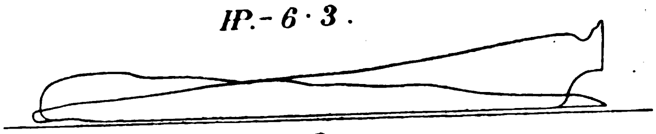

Fig 2.

Pumps Running with the Suction Clack Lids off and the Column empty.

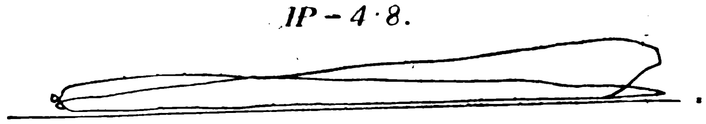

Fig 3.

Motor and first Shaft only.

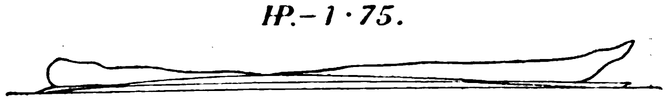

Fig 4.

Dynamo only on open circuit.

This difficulty, however, was successfully overcome. The same plant was tested under different circumstances about three weeks before these tests were made, and the conversion was then 42 per cent., with a delivery of about 42 gallons per minute through 850ft. The rise of efficiency to 44·4 per cent. is probably due to the friction of the bearing surfaces being lessened by wear, and by the shortened length of piping; but more so by the introduction of the belt transmission protecting the motor from the vibration which is inseparable from high-pressure pumping plant.

We may mention that this plant is giving great satisfaction, and that the colliery owners, Messrs. Locke and Co., have given Messrs. Immisch and Co. an order for another dynamo and motor to deliver 120 gallons per minute, through a head of 900ft. The plant is already in hand, and will shortly be delivered.

The Electric Light in Spanish Theatres.—A meeting of the Madrid Theatrical Board was to be held last week to consider the question of the installation of the electrical light, the use of which is to be made compulsory within a period of six months. It is stated that incandescent lamps are to be used to the exclusion of arc lamps, exception being made in favour of a light of the latter description for scenic effects.

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THE LIEPMANN CARBON WORKS.

On Friday last, at the invitation of the directors of the Liepmann Carbon Company, a party of engineers and electricians proceeded to Millwall, and were conducted by Dr. Liepmann over the Carbon Company's Works, where the successive stages in the manufacture of arc lamp and battery carbons were carefully explained. This industry has now been carried on at Millwall for over two years, and the result of the experience gained has been to enable Dr. Liepmann to introduce some important improvements in the manufacture, in which respect the proce s carried out differs from that of other makers. The Liepmann carbons are characterised by an almost entire absence of ash, great density and uniformity of structure, and consequent high conductivity.

The crude material consists of an almost absolutely pure carbon, specially prepared for this purpose by a process of destructive distillation. This material is first passed through a disintegrator, where it is ground into an impalpable powder. After being dried and heated (during which process the powder cakes together in lumps), it passes into a mortar-mill, where it is ground together with a measured quantity of a specially prepared tar. About 60 or 70lb. of the mixed material are ground in one charge, and the process occupies about three-quarters of an hour.

The plastic material which results from this treatment is now in a condition to be moulded into the form either of rods for arc light carbons or of battery plates of any required size. For the first named purpose it is passed through the cylinders of a hydraulic press, where it is subjected to a pressure of 5½ tons on the square inch. The carbon is thus slowly squeezed through a tubular die of the required dimensions, and issues continuously in the form of a somewhat plastic rod, which travels over rollers upon a long table placed in front of the hydraulic cylinder. As soon as the advancing end of the issuing carbon reaches a certain point a number of knives descend and cut the carbon into the required lengths. An attendant immediately removes these pieces, and the operation goes forward continuously. There are two of these presses at work, one forming solid and the other cored carbons; each press is capable of turning out 10,000 feet of 11mm. carbons weekly. The cored carbons are as yet merely hollow cylinders, the soft core being afterwards inserted by a separate process.

The carbons in their present condition, although dense and heavy, are still soft, moderately plastic, and not very coherent. A 11mm. rod 1ft. in length can, for instance, be bent nearly into a circle without breaking, but with a little more strain they break straight across the grain. The next process is the packing of the carbons in iron boxes, together with carbon dust preparatory to baking in the furnaces. This is a process requiring special skill and care on the part of the workman, as a whole charge may easily be spoilt by improper treatment. It was courteously intimated that certain details of the nature of "trade secrets" are connected with this process of baking, and this portion of the operation was therefore not investigated by the visitors.

On leaving the furnace, and after cooling, the carbons are tested for conductivity. This is done by a very ingenious method, which enables an unskilled attendant to separate the carbons of too high resistance with great rapidity. The electrical portion of the apparatus is, in fact, entirely automatic, and all that the attendant is required to do is to turn a handle with one hand and feed in the carbons with the other. The carbons are thereby sorted into two divisions, and those whose resistance exceeds a certain standard are returned for further treatment, the nature of which was not disclosed. The principle of this ingenious machine is very simple. The carbon on passing into the front portion of the hopper forms a shunt to an electro-magnet. As the carbon travels onward, if it is of good conductivity it passes under a pair of brass rods or claws, and falls into a compartment below. These rods or claws are held in position by a spring which is opposed by the electro-magnet; if, then, a carbon of bad conductivity is inserted, the strength of the magnet increases, as it is now shunted with a higher resistance. The rods then rise and guide the carbon into a second compartment.

The next process is to trim and point the carbons upon an emery wheel, and unless they are required to be coppered the manufacture is now complete. The coppering is done in a frame holding about 60 carbons at a time. This is divided into four sections, each of which can be independently raised, and an attendant can be kept constantly at work filling and emptying the frame—that is to say, by the time he has gone through the four divisions, the first lot are just ready for removal.

Another department of the Liepmann works is devoted to the manufacture of battery carbons of any required type, and also of Leclanché cells. The same qualities of high conductivity and purity which fit the Liepmann carbons for arc lighting render them also very suitable for battery purposes. The Liepmann primary battery is a two-fluid zinc-carbon cell. The zinc is cast with mercury, and stands in a sulphuric acid solution. In the outer cell is used a specially prepared chromic acid solution. The carbon is preferably employed in the form of rods, which are set around a collar of lead. A large surface is thus secured, a ring of 6in. diameter being equivalent in active surface to a solid plate of 21½in. in breadth. The Company has had some of these cells in use for nearly two years with satisfactory results. It is found that one 8 candle-power lamp hour costs about ½d. The E.M.F., when first set up, is two volts, but after seven hours' use this drops to 1·8 volt, at which it remains stationary. The cells are made in two forms, one for quick discharge, having a capacity of 150 ampere-hours, with a rate of discharge of over 4 amperes. Another battery of the same type has a discharging rate of 8 amperes, with a capacity of 400 ampere-hours. This battery is intended for temporary purposes. When a permanent installation is contemplated, the Company recommend a type of cell which has a capacity of 300 ampere-hours, discharging at the rate of 1½ to 2 amperes, or a larger size, having a capacity of 600 ampere-hours, discharging at the rate of 3 to 4 amperes.

THE "BLAKEY-EMMOTT" DYNAMO.

We illustrate this week a new pattern dynamo made by Messrs. Blakey, Emmott and Co., of the Northern Telegraph Works, Halifax. It is of the single magnet type, with the poles at the top. The whole magnet is in one U-shaped forging, thus avoiding in the magnetic circuit both the resistance of joints and the use of cast iron. The armature is of the modified Gramme type, and is built up of thin insulated discs of annealed iron, the whole being securely mounted on a gunmetal spider, which is keyed to the shaft, thus ensuring positive mechanical driving. The armature is wound with only one layer of wire. The commutator consists of 40 sections of specially hard drawn copper insulated with mica. There are two brushes on each side, each separately adjusted and fitted with hold-off catch. The shaft is of steel, the bearings are of best gunmetal, and are of ample length; sight feed lubricators are used, by means of which the quantity of oil delivered can be readily seen and adjusted. The pulley is wide, thus favouring steady driving. The whole machine is put together on a strong cast-iron base, which makes a very rigid foundation. The machine under notice, which is compound-wound for constant potential, is intended for an output of 60 amperes and 100 volts, the speed being 1,100 revolutions per minute. The cross sectional area of the magnet bars is 30 square inches. The total cross-sectional area of actual iron in the armature is 20 square inches. The total excitation of field-magnets at full load is 12,130 ampere-turns. The total strength of useful field is 378 lines (English measure). The density in the magnet cores is 12·6 lines per square inch, and in the armature core 18·9 lines per square inch. The length of wire on the armature is 360ft., which is at the rate of 43·2in. per volt, or at a peripheral speed of 3,000ft. per minute, at the rate of 37·3in. per volt. The total weight of copper in the machine is 95lb., and in the armature

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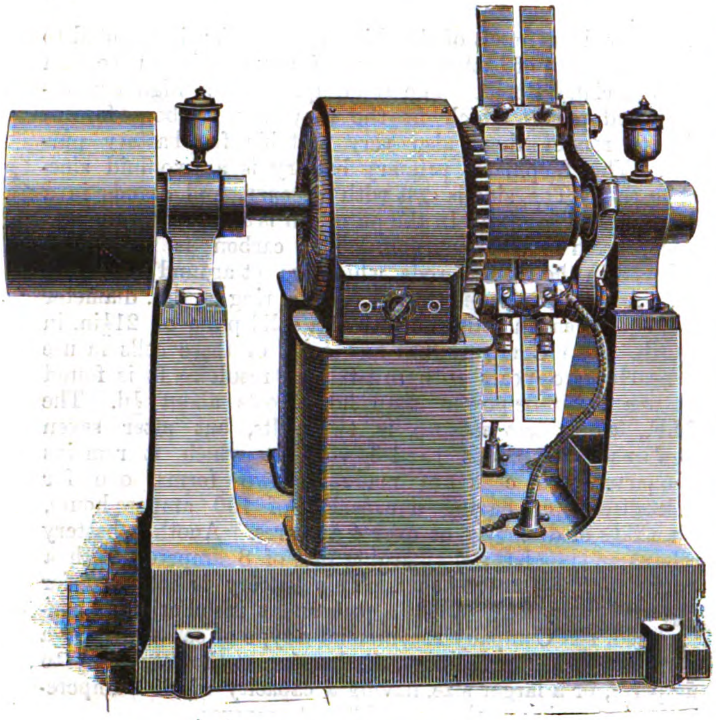
alone 13lb. This gives an output of 63 watts per lb. of copper in the whole machine, and 461 watts per lb. of copper in armature only. The electrical efficiency at full load is over 92 per cent. The machine keeps cool after long runs, and there is a total absence of sparking at the brushes. This type of machine is now being constructed by Messrs. Blakey, Emmott and Co. in different sizes, intended for outputs varying from 10 to 1,000 lamps. We may add that the machines are mechanically well finished, and the electrical efficiency of the larger



The "Blakey-Emmott" Dynamo.

machines is still higher, an 18-unit machine giving over 95 per cent. electrical efficiency.

THE LIGHTING OF LEAMINGTON.

In our issue of October 21 we gave a description of the mechanical arrangements adopted at the Central Lighting Station at Leamington; we now proceed to the electrical details, merely reminding our readers that the dynamos are driven by cotton ropes from a counter-shaft. Power is furnished by six Robey engines, each of 200 horse-power.

The Dynamos.

The installation, it will be remembered, has been carried out by Messrs. Chamberlain and Hookham, of Birmingham, and dynamos of the Hookham type are employed. There are six machines, each having an output of 500 amperes, at 110 volts and 760 revolutions, and supplying current for 1,000 lamps of 18 candle-power. A description of this type of machine will be found in *The Electrician*, October 1, 1886. These machines have double horizontal field-magnets, shunt-wound, with drum armatures. The winding is somewhat similar to the Brown "Oerlikon" machines, the wire lying in grooves cut within the cylinder close to the surface, so that this armature presents to the field-magnets an unbroken iron surface. The armature is 25in. long by 10in. diameter, and has 18 effective turns. The electrical efficiency at full load is given as 97 per cent., and the commercial efficiency 95 per cent. Each machine weighs 72cwt., and occupies a floor space of 8ft. by 5ft.

The Mains.

The mains are laid out upon the three-wire system, and two distributing boxes in different quarters of the town are put in as sub-centres of constant potential. These are connected with the central station by feeders, and the potential is kept constant by a system of indicators with hand regulation. In fact, the Edison system is closely followed in these details. The sizes of the mains were all calculated by Dr. John Hopkinson. The conductors were supplied by Callender's Telegraph and Bitumen Company, and are laid in trenches lined with brick. The cables are laid on wooden bearers supported on slate brackets, and the trench is covered in with stone slabs. The total length of the trenches is 3,500 yards, and the distance to the farthest consumer is 1,850 yards. The total length of the main and sub-main conductors is 13½ miles, and at 65deg. F. the insulation distance has been found to be 500 megohms.

The Meter.

The Hookham meter is of the electro-motor type. The instrument is a coulomb and not a watt meter. The current to be measured passes through the armature only, the resistance of the coils being less than one-six-hundredth of an ohm. In one pattern permanent magnets are employed for the field—an arrangement which we presume contemplates the necessity for occasional re-calibration. The meter is said to register accurately for any number of lamps above three, but below that number its indications are slightly in favour of the consumer. The rate of rotation of the armature never exceeds 88 revolutions per minute. We shall be pleased to hear of the continued success of this instrument.

The total number of lamps at present hung is 1,500, of which 183 (incandescents) are in the public streets. Considerable confidence is expressed that the whole capacity of the plant, 6,000 lamps, will be taken up within six months. The price charged per Board of Trade unit is very low, varying from 4d. to 7d., or from about ¼d. to ½d. per lamp hour.

ELECTRIC LIGHTING ON STEAM YACHT "THETIS."

This handsome yacht, which has just been built for Mr. John Donaldson, of Chiswick, has been fitted with a very complete installation of electric light by Messrs. Muir, Mavor and Coulson, of Glasgow. About 100 lights are fitted throughout the ship, electric lights being used in the masthead and side-signal lamps and in the anchor lamps. The fittings in the saloon, deck houses and cabins are of a very handsome type, and the globes, which are egg-shaped, are about two-thirds obscured; the upper third being clear allows the light to strike directly on the white ceilings, which reflect the light, adding considerably to the effect. Portable hand-lamps are provided in each of the six large store and baggage rooms in the hold, at the steam steering gear, and in the engine room, for examining the accumulators, and for the bilges, &c. There is also a gangway lamp, enclosing three 50 candle-power lamps, which may be suspended from a small special davit on either side of the navigating bridge; a strong diffused light is thus thrown along the ship's side, which is a great convenience for boats leaving or coming alongside.

Another beautiful addition to the installation is a projector. Pedestals, to which the cables are brought, are fixed on either side of the bridge, and the cylinder containing the lamp and mirror may be mounted on either side as required. (When not in use it is secured on the centre line of the ship.) To extend the range of usefulness of this interesting adjunct a dispersing lens may be fixed to the front of the projector. This disperses the rays in a horizontal direction, giving a flat beam when it is desired to light a large area of quay side or beach for the use of small boats when embarking passengers, water or provisions. The wiring of the ship is divided into five circuits, controlled from the upper platform of the engine room, where the switchboard and measuring instruments are fixed. Double pole fuses are fixed on the switch board for each circuit, and from these fuses the cables are led directly to five distributing boxes in various parts of the ship. All the branch wires converge from the lamps to these boxes, and are connected to the cables through double pole fuses. The distributing box for the lamps in machinery space is fixed in the engine room, and is of cast brass, perfectly watertight; all wires in engine and boiler rooms are sheathed with lead. The advantages of such a system of centralised double pole fuses are obvious. The fuses and switches throughout are mounted on slate bases, and the cables are encased in substantial teak wood casings. In each case where a watertight bulkhead is pierced the wires are brought up to the upper deck and down again as required, no holes being allowed in bulkheads below the main deck.

An accumulator with a capacity of 600 ampere-hours is fixed in the engine room beside the generating plant. The boxes, which are of metal alloy, are arranged in three tiers up the ship's side. They are set upon glass insulators, and each cell is separately secured in place by a system of levers and screws, completely insulated by glass insulators. The generating plant consists of a "Willans" central valve compound engine, coupled direct to a Siemens dynamo, which is wound to give 120 amperes at 65 volts as a single shunt, and at 50 volts as a compound machine at a speed of 400 revolutions per minute. The engine is fitted with a Willans governor, a sight-feed lubricator, and a tachometer. A somewhat unusual feature of the installation is a complete auxiliary condensing apparatus; this has been designed and manufactured by Messrs. Thornycroft. It consists (in addition to the copper condenser and hot well) of a small double acting vertical

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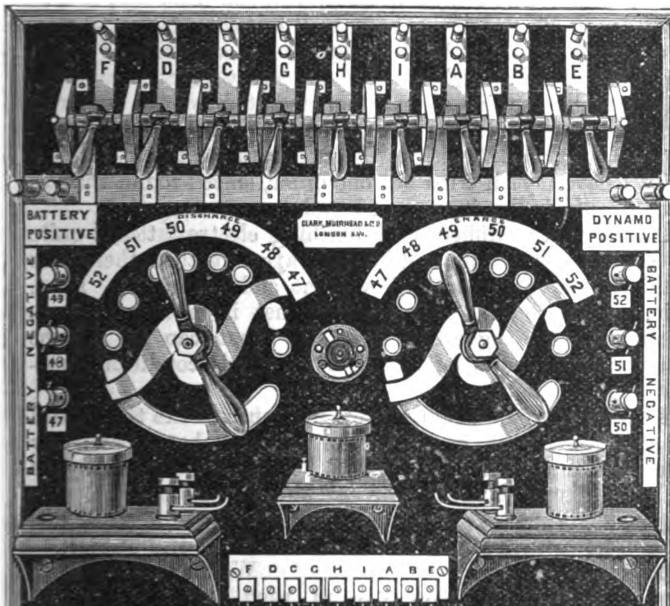
engine, running at 400 revolutions per minute, driving through worm gearing a shaft to which are coupled by cranks the circulating air and feed pumps. A three-way cock is fitted in the Willans engine exhaust pipe, so that the exhaust may be directed into the main condensers, the auxiliary condenser, or the atmosphere. The feed water from the auxiliary condenser may be delivered to the main or to the auxiliary boiler. The complete plant, consisting of the dynamo and Willans engine, the condenser and circulating gear, and the storage batteries, is arranged on the starboard side of the engine room between the starting platform and the ship's side, but does not in the least encroach on the space required on the platform, while every part is easily accessible. The arrangements appear admirably adapted to the ship, and no trouble has been spared to make this one of the most perfect installations afloat.

ELECTRIC LIGHT SWITCH-BOARD, BY LATIMER CLARK, MUIRHEAD AND CO.

The adjoining figure represents the arrangement of the switch-board, supplied by Messrs. Latimer Clark, Muirhead and Co., which they specially designed for the installation at Lloyds, Barnetts, and Bosanquets Bank. The following description is furnished by the makers :—"The voltmeter is connected by one of its terminals to the connecting bar carrying the cables from the positive poles of dynamo and battery, and by the other terminal to the lever of a small switch in the centre of the board. Readings of the E.M.F., at which the installation is being supplied, are obtainable by turning this lever to right or left, connection thereby being established with the charging or discharging circuits respectively through the large six-way switches. Two ammeters are permanently affixed, giving the strength of current in the two circuits.



"The upper part of the board comprises nine main switches, corresponding to the positive cables of the nine sections into which the lamps on the premises have been divided, and on the lower edge are nine fusing bridges inserted in the negative mains.

"The Phœnix fire regulations were complied with in regard to the wiring throughout the building, and by mounting the whole of the apparatus on a solid slab of slate 3ft. square by 1¼in. thick, secured to the wall in a wooden frame. Ayrton and Perry's spring voltmeter and ammeters are employed, manufactured by Latimer Clark, Muirhead and Co."

PRIMARY BATTERIES FOR ILLUMINATING PURPOSES.

(Continued from page 19.)

The Upward Battery.

A decided departure in primary batteries was brought out in July, 1886. This was the Upward battery, in which a gas is used electrolytically instead of a liquid, thus dispensing with the use in the cells of acids and depolarising solutions. The battery consists of glazed earthenware cells divided into compartments, containing ordinary carbon plates surrounded by crushed carbon. These divisions alternate with chambers in which ordinary commercial zinc is placed in blocks. The chambers are filled with plain water and the compartments containing the carbons are permanently closed with cement. Electricity is generated by chlorine gas, which is admitted to the closed chambers, and circulates from cell to cell, giving the high electromotive force of 2·1 volts, and maintaining a constant current of electricity without the use of a depolariser or any acid or chemicals in the cells. All the attention which the battery requires is the addition of a little water about once a week, and the renewal of the zinc about every six months. The manufacture of the chlorine gas (which is non-explosive under any circumstances) is very simple. The apparatus which is seen in the illustration consists of an earthenware pan, B, containing manganese, a jar, A, for the hydrochloric acid, and some ordinary drain pipes, D, cemented together for holding the gas. Once in twenty-four hours a small supply of acid is admitted on the manganese by turning a tap for a minute or two, a gauge on the jar A marking when the required quantity has been admitted, the acid being neither seen nor handled. F is a clockwork switch. Gas is then produced, the battery working on quite automatically as long as there is gas, and the making of gas only taking place when the gasholders are empty. The presence of the gas, which is of a yellow colour, is indicated by glass globes fixed upon the holder connections. The replenishing of the acid jar depends upon its size, the ordinary jars holding sufficient for fourteen days' consumption, the manganese being exhausted in about that time. The current, when generated, is stored in the accumulators E, which provide for the lighting of the lamps, with absolute steadiness and constancy at all times. The current can also be used for driving small machines, and for other useful purposes.

The author recently inspected an installation at Messrs. Woodhouse and Rawson's, which is in use for lighting the offices. It is equal to a supply of 700 watt-hours of current, or, put in other words, is capable of driving twenty-four glow lamps of 10 candle-power each. The arrangement is slightly different from that shown in the illustration, which only occupies a space of 12ft. by 4ft. by 9ft. high. The plant at Messrs. Woodhouse and Rawson's is placed in a recess in the vaults of the building measuring only 5ft. wide by 6ft. deep and 8ft. high, the gasholders being sunk a foot into the ground, and the accumulators and switch occupying two small shelves in front of the main plant. As a matter of fact, the plant can be placed anywhere—in a cellar, shed, or on the roof—being unaffected by frost, and occupying but a small space. It will be seen that the apparatus is simple in construction. It, moreover, requires no special skill in management, and is not likely to get out of order. Its further advantages are that it works almost automatically, is noiseless, free from obnoxious fumes, and appears to give no trouble in working It is stated that the working cost was formerly equal to that of gas at 8s. per thousand ; but that it is now much less, owing to some improvements recently introduced into the generating apparatus by Mr. Upward. Dr. Oliver Lodge, of University College, Liverpool, had an Upward battery at work in his laboratory for several months, and he reported very exhaustively, and at the same time favourably, upon it. The gist of his report is that nearly all the defects of other batteries are absent from it, and he concludes by congratulating Mr. Upward upon the energy and perseverance with which he has tackled and overcome one difficulty after another, and so developed from a somewhat unpromising beginning a really practical and successful primary battery, and we here may well do the same.

The Regent Battery.

The Regent battery was brought out in August, 1886, with the object of overcoming polarisation—that is, the collection of hydrogen gas on the negative element—and local action, which is produced by irregularity in the composition of the positive element, some parts of which are more highly positive than others so that local currents are set up, thereby consuming the metal and exhausting the battery. This was a two-fluid battery, and consisted of an outer cell of porcelain, and an inner cell of porous clay, rendered highly conductive by a special process. The inventor claimed to be able to reduce the electrical resistance of the porous septum without at the same time increasing its porosity to liquids, thus limiting the diffusion whilst reducing the internal resistance. The active or positive element of the battery was an alloy, consisting principally of zinc, so treated that repeated amalgamation was obviated. The plate remained perfectly bright during consumption, and economy of working by the absence of local action was claimed for it. The other element of the battery was a carbon plate immersed in an oxidising solution, which was said to combine cheapness with constancy of action and almost complete freedom from fumes. The author has recently endeavoured to discover the whereabouts of this battery, but without success. It is noteworthy as being one of the first to be utilised for the purpose of mining lamps.

The Pollak Battery.

In October, 1886, Messrs. G. Binswanger and Co. (now the General Electric Apparatus Company) introduced a primary battery which was intended not so much to supply a constant light as for use where an immediate, convenient, and safe light is required for short periods. This was the Pollak battery, each cell of which consists of a glass jar, at the bottom of which is the zinc electrode. The other electrode is carbon, made by Mr. Pollak's process, which ensures great porosity, a large surface, and, at the same time, good conductivity. The lower part of the carbon is plated with copper, or in some cases a small piece of copper wire is suspended in the fluid and connected to the carbon. The zinc of the cells for lighting purposes is covered with sand, and the exciting solution is sal ammoniac dissolved in water. When thus charged the action of the battery is two-fold. First, a local action is set up between the carbon and copper, which causes the reduction of part of the charging fluid and pro-

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duces combinations of copper. In the case of sal ammoniac, chloride of copper is produced, colouring the fluid blue and forming the depolariser of the battery. When the outer circuit is closed the action is that of a carbon, zinc, sal ammoniac battery, the nascent hydrogen reduces the copper chloride to copper, which is again tranformed into copper chloride. Thus the battery constantly forms its own depolariser, *i.e.*, it recharges itself, and therefore such a battery should be one of the most constant known. As will be readily understood, this battery depends largely on gravity, both to prevent local action on the zinc and capillary attraction; it is therefore essential that the quantity of copper solution should be regulated, and also that the cells should not be moved or shaken. By the kindness of Mr. Binswanger, the author is able to place a Pollak cell and a glow lamp upon the table, more as a matter of history than anything else, for, with a creditable frankness, Mr. Binswanger informed the author that the battery was found wanting in practical use. The E.M.F. proved to be so small and the resistance increased so considerably with a number of cells that it had to be given up. Still, as a novel and an ingenious primary battery it had its merits.

THE UNION BATTERY.

At the close of last year the Union battery was brought into public notice, and its working was shown to the author. This is not a primary battery in the strict sense of the term, although it is claimed that it is so to a certain extent. The installation which the author inspected consisted of a battery of 20 cells, which provided the current for 16 Woodhouse and Rawson glow lamps of 12 candle-power each, an excellent light being given. Each cell in this battery is contained in a wood casing measuring 11in. long by 6in. wide and 7in. deep. The whole weighs 20lb., and is said to have a capacity of 115 ampere-hours. Each cell contains six anodes and seven cathodes immersed in a solution of sulphuric acid. The negative plates are specially prepared, and are set into a very hard and durable substance, possessing great porosity and conductivity. They will not only bear transport, but can be stored dry for use at any time. The conductor is so protected as to prevent its oxidation, thus avoiding loss of capacity by the buckling of the electrodes, and the active material cannot become detached or disintegrated. The cathode is spongy lead, and the whole constitutes a feeble primary battery. The plates are therefore removed from the cells when exhausted, charged from a dynamo, and replaced for use. In these batteries there is said to be no waste of power by local action and consumption of expensive material. The *modus operandi* is to charge the plates at the works, and to deliver them to consumers, who use them until they are exhausted, and then send them to be recharged. By favour of the Union Electrical Power and Light Company the author is able to illustrate this system by a battery and glow-lamps driven from it.

(*To be continued.*)

CORRESPONDENCE.

THE TEACHING OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am much obliged to the reviewer of my "Electricity" for the very careful consideration that he has evidently given to my book. It is, unfortunately, very seldom that the writer of a critique gives so much attention and time to the book that he is reviewing, and still more seldom does he bring into such prominence all that he recognises as deserving commendation, while advancing almost with hesitation his adverse criticism.

I understand that it is with the *order* in which I have taken the various parts of the subject that my reviewer finds serious fault. He would, for example, begin with the voltaic circuit, arrive at the consideration of magnetic fields through the phenomena of the electric current, at permanent magnets through solenoids, and at electrostatics (perhaps) through the phenomena of the Ruhmkorff coil.

At the present moment I am myself too much used to think in my own lines to be a good judge of an order of treatment so radically different from my own; hence, I would be understood to be rather advancing reasons in favour of my order than opposing as mistaken the order suggested in the critique.

I may, perhaps, begin by saying that the whole question with me is—what is the best order for *teaching* purposes? From a physical point of view, I quite admit that the order followed in my book presents "geological faults."

Now it seems to me that if one begins with the voltaic circuit there is danger of confusing the learner by the presentation of too many new conceptions at once; for we are concerned at the same time with electric quantity, electrostatic potential-difference (from point to point along the wire), magnetic fields, and magnetic potentials, as well as other matters that I will not specify. I should, myself, feel it very difficult to know where to begin, assuming, as I do, that the learners are not only strange to the subject, but also young and devoid of much mental training.

My idea was this. First to introduce the learner to the conception of fields of force and lines of force, and also to give him some ideas of exact measurement and of a rational system of units in the comparatively simple domain of "elementary magnetic phenomena." I therefore took this part of the subject first, not because it naturally or physically came first, but because it gave a good preliminary training from the teacher's point of view.

Next came the true beginning of the subject, and I chose electrostatics for the following reason:—It seemed to me that a sound understanding of electrostatic potential was certainly to be aimed at, and that at any rate *some* knowledge of it was desirable before discussing the voltaic circuit. Now, this part of our subject can be best attacked by a study of electrostatic phenomena where we are concerned with strains and stresses only, and not with what I may call complicated dynamic phenomena also.

When once the learner has mastered separately the ideas connected with magnetic fields on the one hand, and electrostatic potential differences on the other, he is in a condition to observe intelligently the phenomena of the voltaic circuit, and there will be no need for long digressions on the principle of the galvanometer, or on electrostatic potential as involved in Ohm's law, &c.

I do not wish to take up more space with explanations as to my reasons for the order chosen; I have said enough to show that perhaps the best order in an educational book may not be that order in which there are fewest "geological faults"—not, in fact, the most natural order. But, at the same time, I recognise the fact that a teacher who spent many years in carrying out practically the line of teaching suggested by my reviewer might very possibly find out ways of overcoming what appear to me to be great difficulties. In six years' teaching of electricity I have myself tried but one order, since I found that, as far as I could judge, it answered well.

As regards the difficulty of teaching electrostatics, I quite agree with the reviewer, and have always felt that there was in this much room for improvement and alteration. Here, again, one has to consider not only what is most true, comprehensive, and suggestive, but also what can be taught clearly and without confusion to boys. This condition somewhat ties one's hands.

In closing I would again express my sense of the thoughtful and considerate way in which the reviewer has treated my attempt at a school "Electricity." Whatever may really be the best order and method for teaching purposes, I feel that any one would be a gainer were it possible for him to discuss the matter with such a careful thinker on the subject.—
Yours, &c., WALTER LARDEN.

The College, Cheltenham, Nov. 11, 1887.

PRIMARY BATTERIES FOR HOUSE LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I do not think Mr. Ross in his letter on the relative working costs of batteries and dynamos is quite as impartial as he presumably wishes to be. His reference to the South Kensington installation as instancing the loss of power between the engine cylinder and dynamo terminals is likely to mislead. The installation in question was quite exceptional in this respect, the reason being probably due to the number of lamps exposed in the open to peculiar conditions of humidity. In ordinary well-constructed installations, the efficiency of transmitting mechanism may be taken at ·8, and that of the dynamo at ·85, which gives a total efficiency of ·68, or a loss of 32 per cent. between the engine cylinder and dynamo terminals. Accepting Mr. Ross's data, the cost of coal for one available electrical horse-power will be $\frac{17s \times 12 \times 4\text{lb.}}{2240\text{lb.} \times \cdot 68} = \cdot 53\text{d.}$ per hour.

The cost of labour for small installations is no doubt a very serious item; but let us see how it works out for a user of, say, 62 lamps of 60 watts each, working on an average five

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hours per day throughout the year. 62 lamps × 60 watts = 3,720 watts, or, approximately, 5 electrical horse-power.

The total number of hours will be 365 × 5 = 1,825, so that we get an annual equivalent of 1 horse-power working 9,125 hours.

The wages of an engine driver may be taken at £78 per annum = 18,720d., hence the charge on each available electrical horse-power per hour = $\frac{18720}{9125}$, or, approximately, 2d., and the total charge for coal and labour, neglecting expenditure in leads and other small items = 2 + ·53, or about 2½d. per available electrical horse-power per hour.

Mr. Ross states that the same can be obtained by primary batteries at a cost of 2d. for zinc; but he neglects to include the most important charge of all, namely, that for the oxidising solution; there is here not only the cost of the consumption of the liquid, but of the large residue remaining only partially expended, for to utilise the liquid to its ultimate exhaustion would mean a continual diminution in the intensity of the lights or a gradual reduction in their number.

Then as to the zinc, Mr. Ross's charge of 2d. per lb. is far too low and looks very like an inducement. Users of primary batteries will, in most cases, be retail customers, and I shall be much surprised if they do not find that through ordinary channels they will have to pay from 2½d. to 3½d. per lb.

Mr. Ross's consumption of zinc per electrical horse-power is also too fine. One pound of zinc consumed in sulphuric acid gives approximately 2,255,000ft.-lb., and from this has to be deducted the energy expended in overcoming internal resistance, and in setting free hydrogen from the negative plate; the latter alone when using nitric acid amounts to about 284,000ft.-lb., and with nitrate of soda and sulphuric acid, about a quarter as much again. Hence we have for a lb. of zinc (neglecting loss through internal resistance) about 1,971,000ft.-lb. of available electrical energy, which, if expended over an hour, would be something under one horse-power; but from this must be further deducted the very important and wasteful action of the oxidising solution on the zinc.

In view of the facts presented, I think it will be hard for Mr. Ross to present a clean bill of 2d. for fuel per available electrical horse-power. If we increase this figure by 100 per cent. or so, and then add on the charge for necessary labour or supervision, we shall eventually arrive at a very respectable total.—Yours, &c., N. G. THOMPSON.

4, Queen Victoria-street, Nov. 15th.

THE BENNETT PRIMARY BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue was printed a paper by Mr. Perry F. Nursey on "Primary Batteries for Illuminating Purposes," read at the Society of Engineers on November 7th. Describing the Lalande battery Mr. Nursey says, "Although the battery is the invention of M. Lalande, the credit of attempting to utilise the residual product from it is due to Mr. J. Berger Spence, head of the firm of manufacturing chemists bearing that name. And it came about in the following manner:—The manufacture of oxide of zinc is in ordinary a costly process, and Mr. Spence had for some time past been casting about for a more economical method. Amongst other things he tried electrical decomposition; and whilst engaged in his experiments in that direction he became acquainted with M. Lalande, who he found had a battery which was giving exactly the result Mr. Spence wanted." According to another paragraph in Mr. Nursey's paper, this all took place in 1884.

Now, the Lalande battery is really only a modification of the one bearing my name, the difference being the use of oxide of copper in the iron cell instead of iron or steel borings, and the result of the difference being an increase of quantity and constancy and a decrease of electromotive force, the E.M.F. of a Lalande being less than a volt, and that of a Bennett 1·38 volt. (*See* Sir William Thomson's letter on the subject to *The Electrician*, January 26th, 1884.) My battery was invented in 1881, and on February 1st, 1882 (the date of Lalande's patent being March 27th, 1882), I read a paper on the subject at the Glasgow Philosophical Society, in which special prominence was given to the recovery of zinc oxide from the exhausted solution, and the use of it in the arts, and a bottle containing zinc oxide which had been, at my request, recovered by Dr. Smith, of the North British Chemical Works, from a worked-out cell was handed round the audience. The exact words used by me were as follows:—" . . . . but it becomes even cheaper when it is considered that the chief product of its action is zinc oxide, known in the paint trade as zinc white, which is extensively used as a pigment, and as a substitute for white lead. It can easily be recovered in an approximately pure state from the used-up battery. From the cell which rang the bell for a month 1,458 grains were recovered, the zinc consumed being 1,170 grains. Some of it is on the table before you. Its price in the market ranges from 6d. to 1s. 6d. per lb., according to purity. As this is by no means a bad example, containing only a slight trace of iron, its value exceeds that of the zinc consumed." Further on, referring to the use a gentleman might make of the battery, I said, " . . . . and, after all, when the battery ceases to work he can take it to pieces and paint his house, or a part of it, with the products."

Besides being noticed in the Scotch journals, my paper was printed *in extenso* in several of the London periodicals, notably in *The Electrician*, Feb. 25 and March 4, 1882; the *Electrical Review*, Feb. 18, 1882; and in the *English Mechanic* about the same time; while copious extracts were given in others. It was likewise reprinted in America, and translations appeared in France, Germany, and Italy. All this took place early in 1882, yet in 1884 a company was formed in London to work the Lalande battery, which put forward the recovery of zinc oxide as a novel and principal feature, and in 1887 Mr. Nursey, while posing as an authority on voltaic batteries, gravely adopts the error!—Yours, &c., A. R. BENNETT.

8, Duddington-park, Portobello, N.B., Nov. 15, 1887.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

DEEP SEA SOUNDING AND SUBMARINE TELEGRAPHY.

On Thursday evening, November 10th, at a meeting of the Society of Telegraph-Engineers and Electricians, held at the Institute of Civil Engineers, Great George-street, Mr. Edward Stallibrass read a paper on "Deep Sea Sounding in Connection with Submarine Telegraphy." Sir Charles Bright, M.I.C.E., occupied the chair. Among the visitors present were:—Mr. J. Y. Buchanan, F.R.S.; Staff-Commander Creak, R.N. (Hydrographic Department); Staff-Commander Drake, R.N. (Hydrographic Department); Captain Mordovina (Naval Attaché, Russia); Mr. J. Rattray, F.R.S.E. (Dutch Museum Natural History); Staff-Commander Pearce, R.N. (Hydrographic Department); Captain Stanley, R.N. (Hydrographic Department); Captain Wharton, F.R.S. (Hydrographer, Admiralty); Captain Tizard, R.N. (H.M.S. "Triton," Chatham). The usual routine business having been transacted, the chairman remarked that the subject of the paper to be read that evening scarcely belonged to electricity, but it related to a very important point—the preparation for laying submarine telegraphs. These had been up to the present time almost entirely constructed and laid by England, and to such an extent that there was scarcely a part of the world with which he was acquainted without communication by submarine telegraph. He then went on to compare the present features of cable laying with those of past years, observing that the earlier cables had been chiefly laid in shallow water. The American Government had rendered assistance in taking soundings for the first Atlantic cable; since then progress had been made in deep sea soundings, of which they would hear many interesting particulars from Mr. Stallibrass. It might be taken for granted that the depth of sounding of 46,000ft. given by Captain Dareman and that of 50,000ft. given by an American officer were both errors. Admiral Richards in his last chart of the North Atlantic had eliminated almost every sounding beyond three thousand fathoms.

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Mr. Stallibrass then read his paper, which occupied an hour and a-half in reading, and was frequently interrupted by applause. He commenced by pointing out the close connection between deep sea sounding and submarine telegraphy, and stated that the history of deep sea sounding might almost be said to date from the time of the first Atlantic cable scheme in 1858. The importance of soundings at frequent intervals over a cable route was well recognised as early as 1858; but until quite recently proper attention had not been given to this important matter. After a brief history of early sounding work, the writer touched upon surveys which had been carried out with a view to ascertaining the configuration of the ocean bed: this work having been carried out almost exclusively by Submarine Telegraph contracting companies. The surveys in 1882 of the west coasts of South and Central America and also Messrs. Siemens Bros.' surveys of the North Atlantic were dealt with. Many interesting details were given of the survey of the equatorial Atlantic from Cadiz to St. Paul de Loanda, on the West Coast of Africa. The vital importance of a thorough survey previous to laying a submarine cable was shown by the results then obtained, and some striking illustrations were given of the folly of laying a cable in water of which only rough indications of the depth had been obtained by soundings taken 20 or 30 miles apart, and Mr. Stallibrass urged that the difficulties encountered in several instances, both during the laying and repairing of submarine cables, might have been greatly lessened had a sufficient preliminary survey been carried out. Between Cadiz and Teneriffe alone, a distance of about 700 miles, 673 soundings were taken, resulting in the discovery of two banks, two coral patches, and four other shoal spots. Some of the inclines near these banks were remarkable for their steepness. On the east side of one of these the bottom falls precipitously for 450ft., and on a sounding taken by the "Dacia" during her survey of the Seine bank a precipice of 1,800ft. was found. The paper was illustrated, and a map of the mouth of the Congo was exhibited, showing a remarkable submarine gully or cañon, the contour lines of which were plotted from 202 soundings, many of these having been taken at intervals of less than one mile. In the mouth of this river a depth of no less than 1,452ft. was found. The Thames in a similar locality gives only about 40ft. The gully was distinctly traced 100 miles out at sea. Mr. Stallibrass predicted that far more attention would in future be paid to the way in which cables were laid than to details of their manufacture, which is now practically understood, and their lasting powers will no doubt be greatly increased thereby. After touching on the chemical composition of ocean deposits and their effect on the iron armour of cables, details were given of the principal machines which have been used in sounding, from the oldest form to the most recent modification of Sir William Thomson's pianoforte wire apparatus. Besides the numerous diagrams and maps, microscopes were provided showing some deep sea deposits, and specimens of many machines were exhibited. It seemed almost incredible that probably one-half of the cables now lying at the bottom of the ocean, amounting to a value represented by several millions sterling, have been placed on their ocean bed while those carrying out the work were almost totally ignorant of the bottom on which the cables were destined to lie. The only excuse for this seemed to have been the inefficiency of the sounding apparatus at the time these cables were laid—an excuse which no longer exists.

Discussion.

Mr. Buchanan said he thought the paper had called their attention to most of the things that had to be done in the course of a surveying expedition with a view to laying down deep sea cables. Perhaps its only fault was that Mr. Stallibrass had endeavoured to cover too much ground, and had in consequence disappointed them from time to time in passing from one subject to another so rapidly.

Capt. Wharton, of the Hydrographic Office, referred to the significance of the late discoveries of banks and shoals in the Atlantic. As Mr. Buchanan had pointed out, they showed how very little dependence could be placed on one sounding. A few miles in the open sea seemed exceedingly little when they were steaming about, and if they made a drawing on paper of the depth of the water they would see it did not require a great slope to produce a dangerous shoal within a few miles of a given sounding. Deep sea sounding was still in its infancy, and it really seemed as if it had taken all this time to recognise the necessity of the soundings being taken close together. He felt on his defence with regard to his predecessors in the Hydrographic office, and would remind the meeting that a certain amount of work could only be done in a certain time. The British Admiralty relied more on coast charts. Where the sounding was not continued, and where they were not conversant with the wire, they ran a chance of losing it.

Captain Tizard remarked that he had had no experience with the wire, his sounding having been done with the line. He thought the line would still have to be used for heavy instruments.

Mr. Charles Bright, jun., pointed out the importance of considering deep sea sounding as practically connected with the laying of cables rather than its previous history and utility. The question was to what extent it was warranted for our purposes? The time and expense of sounding should be considered as well as its advantages. Mr. Stallibrass, while treating of the cost of pianoforte wire, had omitted to inform the meeting of the total cost of a ship and crew necessary to do the preliminary investigations. There was no doubt that divers might even be employed with advantage in embedding a cable, but that was scarcely feasible. Whilst agreeing with Mr. Stallibrass on the importance of preliminary soundings, he (Mr. Bright) would remind the meeting of the importance of considering length of time and purse. The cable might be required before the necessary soundings could be completed, and the cost of the cable might have been too great to admit of the additional expense. The case of the "Dacia," mentioned by Mr. Stallibrass, was an instance of the chance of soundings, however close, with regard to the discovery of "banks" or "gulleys." In instancing the Lisbon-Madeira cable it must also be kept in mind that although by far the greater portion of the cables in use had been laid without such elaborate preparations as those recommended in the paper, yet they were mostly in capital working order. Before condemning pioneers for not taking more soundings, we should consider the improvements which have since taken place, and also the greater confidence of the modern public in such undertakings, and thus the greater ease in obtaining money for them. With regard to Mr. Stallibrass's rule about avoiding shallow water in laying a cable, it must also be remembered that a depth of more than 500 fathoms should be avoided where possible in consideration of "recovery work," In conducting chemical analysis of the parts and surroundings of the cable care should be taken to test the specimen before a lapse of time had allowed it to alter its state. An intimate acquaintance with the nature of the bottom was certainly quite as important as a knowledge of its configuration. He (Mr. Bright) presumed that amongst the recent improvements in sounding appliances those described were the ones which the author had had an opportunity of becoming acquainted with, as doubtless there are several others besides those mentioned in the paper.

Mr. Stallibrass, in reply, regretted giving offence to Captain Wharton. He himself rather found fault with the Government than with the Navy. The Hydrographic office dealt chiefly with shoal soundings. He thanked Mr. Buchanan for his kind remarks and the meeting for the vote of thanks, which was very gratifying to him.

SIR F. ABEL ON ELECTRIC SAFETY LAMPS.

At a meeting of the Institution of Civil Engineers, held on Thursday last, Mr. George B. Bruce, President, in the chair, Sir Frederick Abel, C.B., read the second part of his paper on "Accidents in Coal Mines." After describing the earlier systems the author turned to the question of electrical illumination:—

The late Commission had had the matter in view, and although it was only able to describe achievements which could scarcely be considered much more than the germs of the future utilisation of electricity in these directions, yet it was evident that the electric light had an important future before it in mines. Its application to the illumination of the pit-bottom and the immediately adjacent portions of the mine roads obviously presented no practical difficulty, while even this limited utilisation of the light, combined with its employment at the surface and in the buildings attached to a colliery, appeared likely to secure advantages in regard to efficiency of illumination, convenience, and comparative safety. Experiments were carried out at various collieries, at some of which installations of the electric light were provided and are still in use, both on surface and underground. The impossibility of guarding against injury or fracture of such light insulated wires as could alone be applied for connecting movable lamps, for use at the working places, with main conductors leading to the dynamo-machine at the surface, soon rendered it evident that the success in providing the miner with a safe and efficient electric light could only be attained by the production of a perfectly self-contained lamp, not too heavy or bulky to preclude its being carried about underground, and capable of maintaining a supply

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of light equal to that furnished by efficient safety-lamps during the entire period of a working shift. When Mr. Ellis Lever offered a prize, in 1883, for the best safety lamp, two or three attempts at self-contained electric lamps were brought forward, but they could not be said to have afforded any encouragement to the hope that some practical success in this direction was imminent. The subject was, however, attacked by Mr. J. Wilson Swan, and before the Royal Commission concluded its labours Mr. Swan submitted a secondary-battery lamp of sufficiently small and suitable dimensions to be called really portable, though considerably heavier than was desirable. Fitted with a glow-lamp of suitable resistance, it gave a light which was maintained for several hours at between two and three candle-power, and furnished a light of about 1½ candle-power at the expiration of 11 hours. Since then Mr. Swan has made further improvements in this lamp, which weighs now only about 7lb. Thirty of them, supplied by the Edison-Swan Electric Light Company, have been in use at the Risca Colliery for three months, having been employed in connection with every variety of underground work. When brought to the surface at the end of a shift they are recharged with the aid of a simple charging table in connection with the dynamo of the general installation. The London and South-Western Coal Company, the Abercarn Steam Coal Company, and the National Steam Coal Company have recently decided to use these lamps in their collieries, and 3,000 will shortly be supplied for that purpose. Mr. Swan has endeavoured to make a modification of this lamp for inspecting purposes in which a gas-indicator forms part of the lamp, and of which a practical trial is shortly to be made. Mr. James Pitkin has constructed a portable and efficient variety of secondary battery, and has made a near approach towards the production of a good miners' lamp. The results which he now attains in regard to light furnished and maintenance of the light are fully equal to those obtained with the Swan lamp, and the weight is only between 5lb. and 6lb. Several attempts had been made to produce primary batteries in a portable form, of sufficient power to maintain a practically useful light for the purposes of the miner. One of the first to attain somewhat promising results in this direction was Mr. Trouvé, though the maintenance of power of the battery used by him was insufficient to serve any useful purpose underground. Mr. T. Coad submitted a primary-battery lamp which appeared to afford some promise of success, though neither the maintenance of power nor the dimensions of the battery constituted an approach to the fulfilment of practical exigencies. Mr. Schanschieff has constructed a small sulphate of mercury battery which has furnished, in regard to maintenance of power, more promising results than those attained by the batteries used by Trouvé and Coad. Early last year the author had submitted to him by Mr. Blumberg some experimental lamps in which the source of electricity consisted of a combination of small cells of Skrivanow's modification of de la Rue's battery. The elements are zinc and silver foil coated with chloride of silver, the exciting liquid being a solution of caustic potash. The re-charging of small primary batteries for miners' lamps is a more troublesome operation than the restoration of power of the secondary-battery lamps. On the other hand, the employment of the latter necessitates the provision of a generator. The great advantages secured, however, in connection with the necessities of a colliery by the provision of an electric light installation for general purposes, and for the efficient illumination of the pit-bottom and adjacent roadways render their extensive adoption very probable. There are now most substantial grounds for the confident belief that the problem of the successful and thoroughly safe application of electric light in connection with every class of underground work is in course of speedy and complete practical solution.

PHYSICAL SOCIETY—November 12.

Prof. W. E. Ayrton, F.R.S., Vice-President, in the chair.

Lieut. Bacon, R.N., was elected a member of the society.

Owing to the illness of Dr. Shettle, the paper announced to be read by him was postponed.

The following communication was read :—

On a Geometrical Method of Determining the Conditions of Maximum Efficiency in Transmission of Power by Alternating Currents. By Mr. T. H. Blakesley, M.A.

In this paper the author confines himself to the consideration of a simple circuit containing generating, conveying and recipient parts, in which the E.M.F. follows the law of sines. The maximum E.M.F. of both machines are supposed known together with the resistance and coefficient of self-induction of the complete circuit. The variable on which the efficiency of transmission depends is the difference of phase of generator and receiver. A geometrical construction is given by which the phase which gives maximum efficiency can be determined.

Mr. Kapp thought the construction would not apply where the receiver does mechanical work, owing to the E.M.F. not being a true sine function of the time. He also mentioned an experiment performed on a motor driven successively by alternating and direct currents, in which the *apparent* power ($\sqrt{e^2}\sqrt{c^2}$) supplied by alternating currents was about five times that required when direct currents were used, the motor giving out the same power in the two cases. From this he inferred that the ratio of power to weight is much greater for a direct than for an alternating current motor. This he considered a serious drawback to the use of alternate currents for transmitting power.

After some remarks by Prof. Ayrton and Prof. S. P. Thompson, Mr. Blakesley said that by placing a condenser between the terminals of the recipient machine a greater current could be passed through the receiver than that in the generator and line.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

15,217. W. Lowrie, C. J. Hall, and H. W. Kolle. London. Improvements in measuring alternating currents of electricity. November 8th, 1887.

15,299. E. Perrett. Birmingham. Improvements in meters for measuring electricity. November 9th, 1887.

15,310. T. C. Boutet. London. An airo-dynamic motor. November 9th, 1887.

15,321. J. Pitkin. London. Improvements in electrical storage batteries. November 9th, 1887.

15,328. A. Schanschieff. Surrey. Improvements in galvanic batteries. November 9th, 1887.

15,385. E. Hermite, E. J. Paterson, and C. F. Cooper. London. Apparatus for disinfecting impure liquids by electrolytic action. November 10th, 1887.

15,392. H. J. Haddan. London. Improvements in primary batteries (Bernhard Scheithauer, Germany). November 10th.

15,445. E. Jones. London. Improved means for electrically controlling the speed of steam engines. November 11th, 1887.

15,448. G. Frier. London. Improvements in the preparation of spongy lead for use in secondary batteries or accumulators (E. Fischer, Denmark). November 11th, 1887.

15,455. W. S. Rogers. London. Apparatus for connecting a number of separate electrical conductors to one main conductor. November 11th, 1887.

15,498. J. Gale. London. A new or improved combined shutter switch shield and reflector for electric incandescent and other lamps. November 12th, 1887.

COMPLETE SPECIFICATIONS ACCEPTED.

Note.—*All persons interested in opposing a grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

November 12th, 1887.

114. W. A. Leipner. London. An improvement in dynamo electric and electro-dynamic machines. January 4, 1887.

13,092. W. R. Lake. London. Improvements in and relating to the manufacture of material for the production of carbon filaments for incandescent electric lamps and other articles (La Société, A. Cruto and Cie., Italy). September 27, 1887.

13,722. C. E. Ponder, J. Macgregor and P. Harris. London. Improvement in electrical secondary batteries. October 10, 1887.

13,736. A. S. Kimball and G. L. Brownell. London. Improvements in electric spinning and twisting machines. October 11, 1887.

November 16th, 1887.

254. W. Chadburn. Liverpool. Improvements in electrical communicating apparatus, partly applicable to pneumatic and other like communicating apparatus. January 7, 1887.

564. H. Harington Leigh. London. An improved electric motor (J. L. Clerc, France). January 13, 1887.

565. H. H. Leigh. London. An improved electrical transformator (J. L. Clerc, France). January 13.

12,636. L. E. Bathrick. London. Improved means for discharging electricity from paper and other materials while being operated upon in printing and other machines. September 17, 1887.

13,864. F. H. Royce. Manchester. Improvements in incandescent electric lampholders and other like fittings. October 13, 1887.

PATENTS SEALED.

November 8, 1887.

9,730. W. P. Thompson. Liverpool. Improvements in or relating to voltmeters (G. Westinghouse, jun., United States). July 12, 1887.

9,736. W. P. Thompson. Liverpool. Improvements in or relating to connecting alternate current electric generators, and to apparatus therefor (G. Westinghouse, jun., United States). July 12.

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9,741. W. P. THOMPSON. Liverpool. Improvements in or relating to electrical distribution or to apparatus for supplying or distributing electricity to electric railways, incandescent lamps, or other like purposes (G. Westinghouse, jun., United States). July 12.

9,743. W. P. THOMPSON. Liverpool. Improvements in or connected with incandescent electric lamp sockets (G. Westinghouse, jun., United States). July 12.

November 11, 1887.

13,126. J. G. LORRAIN and S. WALTERS. London. Improvements in or connected with reflectors for portable electric incandescent lamps. October 14, 1886.

13,974. J. G LORRAIN. London. Improvements in electric telephony. October 30, 1886.

990. S. W. MAQUAY. London. Improved means for feeding electric batteries and for removing the plates therefrom. January 21, 1887.

7,506. THE NEW PORTABLE ELECTRIC LAMP AND POWER SYNDICATE COMPANY, LIMITED (D. Urquhart and B. Nicholson). London. Improvements in and connected with electric batteries and lamps suitable for miners' use or for analogous purposes. May 23, 1887.

9,732. W. P. THOMPSON. Liverpool. Improvements in or relating to electrical indicators (G. Westinghouse, United States). July 12, 1887.

SPECIFICATIONS PUBLISHED DURING THE MONTH.

14,770, 1886.—F. R. BAKER. Hydro-Carbon, &c., Lamps. (Price 8d.)

15,524, 1885.—F. C. ALLSOP. Electrical Tramways. (Price 1s. 1d.)

16,141, J. R. AND H. F. TOZELAND. Portable Electric Call Alarm. (Price 8d.)

16,177, 1886.—J. GRIFFITH. Wind Motor for Electric Lighting, &c. (Price 8d.)

4,135A, 1887.—H. J. HAIGHT. Electro-Magnetic Clock Time Transmitters. (Price 8d.)

4,303, 1887.—W. MAIN. Electric Batteries. (Price 8d.)

LEGAL INTELLIGENCE.

The Western Counties Telephone Company v. Harding.

In this case, the company, for whom Mr. Lapthorne appeared, sued the defendant, a builder, of Southsea, for whom Mr. Feltham appeared, for £11, being one year's rental of a telephone from the 1st of March last, under an agreement entered into between the plaintiff and defendant, and dated the 31st of December, 1886.

There was no question as to the use of the telephone, but the defence was that the wire was laid on to the defendant's premises for the benefit of the company, in order that he might be communicated with on the subject of repairs. There was a counter claim of £5 odd for breach of agreement.

Eventually His Honour gave judgment for the plaintiff for £5. 6s. 8d.

The Sanitas Company (Limited) v. The G. Condy's Sanitants Company and the Condisanitas Company.

This action was tried in the High Court of Justice on the 27th ult. before Mr. Justice Kekewich.

The plaintiffs (who are the well-known manufacturers of Sanitas compounds so largely used at telegraph stations and on board ship) claimed that the title of the defendant company constituted an infringement of their registered trade mark.

This view was upheld by Mr. Justice Kekewich, who remarked that he had not the slightest hesitation in granting the injunction.

Judgment accordingly.

COMPANIES' MEETINGS.

West India and Panama Telegraph Company (Limited).

The twenty-first ordinary general meeting of the members of the West India and Panama Telegraph Company (Limited) was held at Winchester House, 50, Old Broad-street, on Wednesday last, Mr. C. W. Earle in the chair. Mr. R. T. BROWN, secretary, read the notice calling the meeting and the minutes of the last meeting, which were confirmed.

The CHAIRMAN: Gentlemen, I presume you will take the report as read. [Yes.] Well, gentlemen, it refers to a period that certainly has not been the least prosperous that we have had to submit to you, but it has been marked by some causes of very considerable anxiety to us in the administration of your affairs arising from causes outside the regular business of the Company. I allude, in the first instance, to the long-continued depression under which the West Indian sugar trade has suffered. This depression affects us indirectly, because it contracts the traffic, and it also induces the Colonies to pull the strings of their purse in the matter of subsidies a little tighter than they would if we were in more prosperous times. Those who are more particularly interested in the sugar industry, which is the great staple of the West Indies, are aware of the extraordinary fall in the price of sugar—a fall of about 50 per cent.—and the action of the bounties that are paid by foreign Governments on the export of manufactured sugar from their countries (hear, hear). These bounties amount, I believe, in the aggregate to about £7,000,000 a year, and the effect of this is that the manufacturer of the beet sugar in France, Germany, and almost all of the Continental countries can place it upon this market at a price which is below what it would cost to produce it if it were not for the bounties. The result, of course, is very damaging to the West Indian interest. I may add that after many suggestions a sugar conference has been convened on the subject of those bounties, and is about to be held in London on the 24th of this month, and at it I hope something may be settled to modify the effect of those arrangements of foreign countries, which are so detrimental to West Indian interests. I may state that at this moment there is a little rise in the price, probably due to the shortness of the beet-root crop on the Continent. Another cause of anxiety to us during the half year was the proposal that the French Government should guarantee £40,000 for a cable that was to compete with your traffic to the islands of Martinique and Guadeloupe. The Bill was presented to the French Chamber by the Minister of Posts and Telegraphs, with all the power that he could bring to bear upon it. The promoters of this line—this scheme—gave to the Minister the most extravagant returns as to the profits that would be derived from this business, and it fell upon us to supply to the members of the Chamber that were inclined to oppose this scheme very full statistics of the actual profit probable. The subject was debated at great length in the French Chamber, where very great influence was brought to bear upon the patriotic feelings of the French members. They were told that the English were deriving enormous profits from this business; that the perfidious Briton monopolised the telegraphic communication of the world; that France ought to have her share, and should slip in and take this, at any rate, as a beginning. Well, gentlemen, the French Chamber did not see their way to what was suggested, and referred the matter to the Budget Committee, and they went into the subject (which I need not take up your time to listen to), and eventually the proposal was rejected. The Ministry suddenly fell, and I hope we shall not hear any more of it (cheers). Still, it was an anxious time, and we had a great deal to do in communicating with our agent in Paris, and endeavouring to show that no good would come of it, and what a losing business it would be. We have the satisfactory position to-day of being able to report the repair of that very important link of our cable lying between Jamaica and Porto Rico. The history of that cable has been an eventful one. When we took office in 1874 it was inoperative, and we had no ship wherewith to undertake repairs. It was some time before we got one out with cable on board, and then there were breaks in other cables which had to be attended to. In 1885 that cable was repaired, and it worked for a year. It then failed in a depth of 2,400 fathoms, or about three miles deep of water. It was found that we could not lift it at so great a depth, and we had to go a considerable distance on each side of the break into shallower ground to get hold of the cable and to relay it in nearer the coast of San Domingo and in shallower water, so as to avoid the pitfall into which the cable had been laid in the first instance. We found that the ship had to go for some other repairs, and the cable stock running low we had to bring her home for a fresh supply of cable. On her return to the West Indies in the current half year she entirely completed the repair of that cable. This has been a very expensive business from first to last, and we shall take care that the Colonies know it. The total cost, if we charge the ship's expenses in these different operations, is £50,000, and we have laid in about 439 knots of new cable, which, as the whole cable is only about 700 miles long, makes practically two-thirds of it a new one. This cable is of course a matter of much importance to us, as those islands of the Antilles ought not to be dependent upon one cable. We had hoped that in the report which we laid before you to-day we should for the first time have been able to state that every cable of the Company's system was working, but while the report was in the press the information came of a failure of the Colon cable. It appears that in one of those terrific storms that beat on the Isthmus of Panama, the cable parted about 36 knots from the coast. Our ship is on the spot, and as the break is not in very deep water we expect any moment to hear that the cable has been put through. With regard to the accounts that we lay before you to-day, I do not think that they call for any special remark. I shall be very glad to answer any questions, but they follow very much the same lines that they usually do, and there is no point upon which I can see you will expect me to make any remarks to you. I have received two letters from shareholders suggesting to the Board that something should be done to the ordinary shareholders (hear, hear). We do all we can for the ordinary shareholders in our power ("No, no"). The suggestion that has been made in those letters is practically the raising of a debenture stock in order to satisfy the claims—the prior claims—of the preference shareholders. Well, gentlemen, I am informed that such a course would be distinctly illegal, *ultra vires*, and liable to cause us to be served with an injunction—("No")—and that if we (the Directors) were to do such a thing, we ourselves would be held personally responsible, and liable to any damages that might be laid in claims against us. I therefore think that that scheme—that proposal—is an impossible one. Another proposal is that we should take the reserve fund to pay off these dividends. Now, gentlemen, that the Board is determined not to do. The reserve fund is the key-stone of the whole concern. I showed you just now how, for one cable alone, you may have to dip into it from first to last to the extent of about £50,000. We have 4,000 miles of cable, some of which has been 17 years under water, and therefore I do

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not think the amount of the reserve too much as a security for the whole of the enterprise of the Company, and I therefore, myself, will not be a party to dipping into the reserve fund in order to pay dividends that have not been earned. Upon this point, to put myself quite right from a legal point of view, I requested our solicitors to furnish me with their views, after having read the letters to see what the question was, and this is what they say about it:—"Letters have been received by the Directors and have appeared in the press urging that some action should be taken with a view to improving the position of the ordinary shares with respect to dividend (hear, hear). It has been suggested that the arrears of accumulated interest on the preference shares should be capitalised, and that fully paid shares should be issued to the preference shareholders in extinguishment of their right to arrears of dividend. The Directors are advised that such a scheme would be illegal. There does not seem to be any way of altering the relative positions of the different classes of shares of the Company's capital without either obtaining a special Act of Parliament or getting the consent of every individual shareholder for the reorganisation of the capital. The Directors have no evidence that either of these courses would be acceptable to the shareholders as a body ('yes, yes'), and until such evidence is forthcoming they cannot take any step in the matter." That is what the solicitors—Messrs. Bircham and Co.—have written upon the subject. Now, gentlemen, I come to another class of letter—that which Mr. Morten is writing to the public press. They say "if you have a bad case always abuse your opponent's attorney," but I would like to know what sort of case it is that leads a man to abuse his own attorney, as Mr. Morten has been doing in the public press. You all, as men of business, know how far such a line of conduct as he has been pursuing weakens and damages your Directors in any negotiations that they have to carry on. Here we are held up as grasping—I was going to say rascals—because we take the fees that have been arranged and settled by the Articles of Association; because we take those fees—and I may state here that unless I do have my fees I will not sit here, and I do not suppose anybody else will—we are held up to opprobrium in the public press. Mr. Morten knows nothing about our business, nothing of the negotiations that have to be carried on with the West Indies, nothing of our relations with the Colonial Office, and there is nothing can be more damaging to us than he in his small way can be by the abuse he puts in the papers about us. If Mr. Morten or any other shareholder thinks he can do better with another Board, let them take steps to get a new Board. They can get the Articles of Association changed, and they can get the Directors changed, but I must most strongly deprecate the action taken by Mr. Morton in publishing what he does in the public press (cheers). Gentlemen, I beg now to move:—"That the Directors' report and accounts to the 30th June, 1887, be received and adopted, and that, as recommended by the Board, the payment of 9s. per share on account of arrears of dividend on the first preference shares be and the same is hereby declared."

Mr. W. Ford seconded the resolution.

Mr. William Abbott said that it might not be known to shareholders who had lately come into the Company that it was a reorganisation of a very bad business. He had had a hand in the reorganisation, and had helped to carry it out successfully and place the present Board in office, and the question of fees was at the time made a distinct compact with the Directors. He (Mr. Abbott) tried at the time, assisted by some of the largest shareholders in the Company, to place upon that Board the most successful men in telegraphy, and had succeeded. Mr. Ford was able to advise them legally, and Mr. Holmes had charge of the shipping interest. He did not think that they could possibly get a better Board than they now possessed (hear, hear). They had evolved a system out of chaos, and built up a reserve fund of £125,000, and, excepting for one block still in the way, which he would shortly allude to in fuller detail, they might be said to have turned the corner, and rather more than turned it (hear, hear). The Chairman's speech had not been very cheering; but, then, he never did give a very optimist view of things (laughter). It was a matter of considerable satisfaction that the French Company had come to nothing. The French wanted a share in the profits of telegraphy; he wished to the Lord that they had a share of the losses that had been made by the Panama Company. What was wanted in the Company was that something better should be done for the ordinary shareholders (hear). The letter of their solicitor had made him very raw. He did not wish to approach the Board in any combative or antagonistic spirit, but he had a scheme to propose, and if Mr. Solicitor chose to say that it could not be done he would assure him that they were determined to do it in spite of their solicitor (hear, hear), and he could assure the shareholders that in the person of Mr. Ford they would possess, on the Directors' side of the Board, a very strong advocate. When he and Mr. Ford worked together for the benefit of the Company, some fourteen years ago, they never let the word "impossible" enter into their vocabulary, and they were not going to do so now (hear, hear). The ordinary shareholder was a patient animal, and had not had a smell of a dividend ever since he subscribed his money. The scheme that he (Mr. Abbott) had to propose on behalf of himself and his friends was a scheme that he was confident would work, and that scheme was a scheme for the reconstruction of the capital of the Company. In order to place the financial position of the Company on a more satisfactory footing it was proposed to cancel the £38,019. 6s., dividends overdue on the first preference stock, by an issue of £38,019. 6s. first preference capital, equal to £1. 2s. per share. It was proposed to cancel the second preference capital (£46,690) and the accrued dividends, and to issue first preference shares in the proportion of 75 per cent., or £7. 10s. per share, in exchange for each £10 second preference share, and the dividends overdue thereon. The reconstructed capital account would then stand as follows:—First preference capital £418,666. 16s., and ordinary capital £883,210, making a total of £1,301,876, being a decrease on the present capital and dividends overdue of £32,683. The advantages of the scheme were briefly that the first preference shareholders would receive per share an additional capital of £1. 2s. The present shares are quoted £9. 5s. ex div. Valuing the reconstructed capital at £9 per £10 share (to be within the mark), £11. 2s. capital would be worth £10, showing an immediate increase in value per share of 15s. On the basis of the dividends paid for the past half year, it would take over seven years to liquidate the amount now overdue on the first preference capital. With regard to the second preference shares, the price of these shares was nominally £6. In place of the present £10 share and the accumulated dividend of £4 per share, holders would receive £7. 10s. first preference capital, which at £9 per £10 share would be worth £6. 15s., showing an immediate increase in value per share of 15s. No distribution had been made on the second preference capital for the past seven years and a-half, and as the Company had during the past twelve months paid only one excess dividend of 3s. per share to the first preference, and there still remained a sum of 22s. per share overdue, it followed on this basis that the holders of second preference shares would not receive any dividend for the next seven years until the arrears on the first preference were liquidated. By the scheme proposed each £10 second preference share would be exchanged for a freely marketable security earning a dividend of 9s. per annum. As to the ordinary shares, these would be immediately brought within range of a dividend. The Company had for the past year, after placing £6,000 to reserve (now amounting to £125,903) and providing for exceptionally heavy expenses in repairs to cables, paid in dividends on first preference capital, £25,922. 5s. The proposed 6 per cent. first preference capital would require £25,120 per annum, leaving as surplus £802. 5s. Any dividend paid on the ordinary capital would, of course, materially improve the price of the preference shares, and the prospect of such a distribution was by no means remote, as the traffic for the past four months showed an increase of £2,035, or 12 per cent. on the gross receipts. Such a scheme, he thought it would be conceded, was in the interest of all classes of holders (hear, hear). The debenture holders would not object to it (no). The first preference shareholders would not object to it (no), for their arrears would be capitalised by a payment in stock which they could take into the market and turn into sovereigns, and the second preference could not object to it (no), but yet as regarded the second preference he had been told since he came into the room that those shareholders were not treated liberally enough. Well, that could be a matter for discussion. He and his friends were now quite prepared to meet the Board in a friendly conference—not a committee, he hated committees—and to see what they could do to round off rough corners and make things fit, and arrive at something which the Directors could confidently recommend to the whole body of shareholders. To do the whole of what he had laid out in his scheme would only require an increase to their capital of £26,000, and they would be enabled to wipe off £59,000 of arrears. Their reserve fund now was 30 per cent. of the preference capital. He thought that if the Directors could only see their way to the adoption of this scheme that it would effectually end the constantly recurring disappointment of shareholders and their complaints, who, wanting a Jonah, pitched on the small matter of the Directors' fees. The day after the scheme was adopted and carried out there would be a considerable increase in the value of the securities of the Company in the market. So far in their time of probation—the past fourteen years—the Board had done wonderfully well. No one could have done better. Himself and the friends who he represented were well satisfied with the work that they had done, and they now asked them to carry out the scheme to be placed before them (loud applause).

Mr. Morten highly approved of the scheme of Mr. Abbott. It was a good workable scheme, and if it only gave the second preference a little fairer treatment, he (as perhaps the largest shareholder in the Company) would be glad to give it his approval and support. He thought that the Directors had during the past seven years and a-half taken a too pessimistic view of the affairs of the Company, and on that head he had prepared an amendment; but as he did not desire to be in any way hostile to the Board, but to support anything that was of advantage to the general body of shareholders, he would simply content himself with reading the amendment at the end of his speech, and handing it in without proposing it. The result of the gloomy view taken by the Board was shown in the low price of the shares of the Company in the market. He was prepared to purchase any of the second preference shares at £6 each. He offered that challenge to them. As regarded the remarks of the Chairman on what he (Mr. Morten) wrote to the papers, he was not ashamed of what he wrote; he always put his name and address to what he wrote, so that there might be no mistake about it. He was not one to stab in the dark; he stood up and used his fists like an Englishman. Mr. Abbott's scheme was, he might again state—and he held the Articles of Association in his hand—a workable one, and one that deserved support if the second preference shareholders were only a little better treated.

Mr. Newton said that the law was just the same now as it was when they capitalised the dividends for the Company on a former occasion, and——

Mr. W. Andrews, interrupting, said that it must be borne in mind by Mr. Newton that on that occasion the old company was wound up and the shareholders of the old company received as their capitalised dividends shares in the new Company.

Mr. Newton said that he thought the scheme of Mr. Abbott a good one, and if carried out might put an end to the constant haggling about Directors' fees. He believed it could be carried out. He had assisted in a much more difficult operation in another company, where they had induced the preference shareholders to give up their preferential rights altogether in order that the ordinary shareholders might get a dividend, and the result was that the capital value doubled in three years. He liked to hold preference shares when ordinary shareholders got a dividend they

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were then of value, but it was doubtful in many instances whether a preference share was of much value unless the ordinary shareholders got a dividend. He thought that the manifestation expressed by that meeting showed a unanimous feeling of approval of the scheme of Mr. Abbott (cheers).

Mr. A. BAKER endorsed the scheme of Mr. Abbott, and thought that its great recommendation was the small amount of £26,000 only he required to carry it into effect.

Mr. ABBOTT said Article A of the Articles of Association gave power for an extraordinary meeting of the Company to increase the original capital of the Company by the issue of new shares to such amount as might be deemed expedient, and, therefore, if he understood the English language, it only required an extraordinary meeting to carry this into effect, and it might all be done before the end of the year. He did not think that the Chairman or the Directors objected to it.

The SOLICITOR said he wished to put himself right as to the letter he had written, and he wished to state that in the matter submitted to him he would stand or fall by what he had written; but if they obtained the consent of the whole body of shareholders or got a special Act of Parliament, then they could do what they liked. That letter was not written with any hostile feeling to shareholders (hear, hear).

Mr. GRIFFITH thought that Mr. W. Abbott's scheme was a very statesmanlike one, but they had not all the shareholders in that room—perhaps there were 150, and it would be a matter of some difficulty to get all the shareholders to assent ("No, no," and a voice, "We can try.")

Mr. ABBOTT said he believed if a form of assent was sent round they would not get a single refusal to sign it.

The Rev. Mr. GREAVES feared a circular would not be of much use; some would sign and some take no notice of it. He cited the case of the East London Railway Company, in which he was interested, and stated that the way in which a similar arrangement was carried out was by meetings of holders of the various classes of securities, and a quiet and business-like discussion over the affairs. He approved the scheme.

Mr. ABBOTT thought that they could not expect the Directors to decide as to the merits of the scheme offhand; he confessed that he had rather sprung it upon them, and he thought that it might be left to the Directors to discuss and go thoroughly into the matter in the board room, and then see whether it was not just the scheme that—with perhaps a few modifications—they could lay before the shareholders (hear, hear).

The CHAIRMAN confessed that it was quite impossible for him to give an absolutely definite answer now. He might speak for his Board, and say that as far as he could see at the moment the scheme had their approval (the Board: Hear, hear), and they would promise at once to give it their utmost attention.

Mr. ABBOTT expressed his gratification, and said that he knew that Mr. Ford would not allow himself to be beaten if it were possible (and he knew it was) to carry the matter out.

Mr. FORD said that if a thing was in the interest of the shareholders, the Directors were always ready to act within their powers, and if they did not possess the necessary powers then they were ready to seek them (cheers).

Mr. NEWTON asked whether the Chairman would promise to call a meeting within a month or two months, and lay before the shareholders the result of the deliberations of the Board (hear, hear).

Mr. FORD said that the matter would of course have their immediate attention.

Mr. MORTEN hoped they would try and do a little better for the second preference.

Mr. FORD said that that, in common with other matters, would receive due consideration.

Mr. NEWTON asked the amount of capital requisite to call an extraordinary meeting. The feeling was in favour of a meeting, and he thought that the Chairman ought to say they would call one.

Mr. QUILTER thought that the meeting was unanimously in favour of the scheme, and as far as he could see it was a good one. Would the Chairman pledge himself to carry it out? The shareholders would leave the room more pleased if they had that assurance.

The CHAIRMAN said he would pledge himself to consider it at once (cheers).

Mr. FORD said the amount of capital that could call a meeting was one-tenth of the whole.

Mr. NEWTON thought that perhaps it would be as well if they passed a resolution that day recommending this scheme to the Directors.

Mr. ABBOTT said that the Board had met the shareholders so fairly that day that he did not think that it was right to press them too hard (hear, hear). Let the shareholders leave it to them, with the knowledge that they would act at once (hear, hear).

The CHAIRMAN then formally put the resolution for the adoption of the report and declaration of the dividend to the meeting, which was carried *nem. con.*

On the motion of Mr. VEARS, seconded by Mr. HOWARD, a cordial vote of thanks was accorded to the Chairman and Directors; and the CHAIRMAN having briefly responded the proceedings terminated.

Rochester and District Electric Lighting Company.

The first general meeting of the shareholders of this Company was held on Tuesday night at Chatham, when it was decided that, notwithstanding the very limited support which had been accorded the promoters, operations should be commenced as speedily as possible, and an endeavour be made not only to supply Chatham and Rochester with electric light, but to go as far as Maidstone and Gravesend. The number of shares applied for is up to the present 667, and of these 446 have been taken up by the Directors. The lack of support on the part of the general public has caused the Directors to hesitate before incurring any financial liability; but they have agreed to subscribe any further capital which may be necessary, and, as a preliminary step, have signified their intention to pay up at once in full the shares already taken. They are confident of being able to supply the electric light at a rate corresponding to 3s. per thousand, and, taking all circumstances into consideration, they believe this price will in the end be much cheaper than gas, which is sold in the district at 2s. 6d. per thousand. It has not yet been definitely decided what system to adopt, but negotiations are taking place for the supply of engines, boilers and dynamos. A large number of people in the neighbourhood have expressed their desire to have the electric light.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended the 11th inst. amounted to £4,609.

OPPERMANN ELECTRIC LIGHTING AND MANUFACTURING COMPANY (LIMITED).—The principal in the formation of this Company, which was noticed at page 22 of our issue of 11th November, appears to be the same Carl T. J. Oppermann who was a bankrupt in November, 1885, and who, on being examined before the Registrar, stated that he had since his bankruptcy been a salaried servant to his brother, Lawrence Oppermann, who was then a minor. In the short period since his discharge he appears from the agreements made in this new Company to have acquired the business of this brother, a minor. This is curious, especially as the creditors under the bankruptcy have not yet received one farthing from the estate, nor will there be any appreciable sum for distribution.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts for the week ended November 11th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £3,651.

TERMINATION OF AGREEMENT.—We understand that the agreement between the Telephone Construction and Maintenance Company (Limited), of 109, Farringdon-road, London, E.C., and Mr. George Allanson Mason (late of the American Telephone Company) is about to be terminated.

PERSONAL.—We are informed that Mr. René Upward, until recently the head electrician to the Woodhouse and Rawson Manufacturing Company, has resigned his appointment.

REMOVAL NOTICE.—Messrs. E. L. Berry and Co. inform us that they have removed to more convenient premises, at 8, Wardour-street, London, W.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. NOV. 16.		BUSINESS DONE WEEK ENDING NOV. 16. Highest.	Lowest.
Anglo-American	38½,	39½	38⅞	38½
Do. Preferred	63,	64	64½	62½
Do. Deferred	14½,	15½	15	14⅛
*Brazilian Submarine	11¼,	11¾	11⅞	11⅝
Cuba	11¾,	12¼	12	11⅞
Do. Preference	18,	19	—	—
Direct Spanish	2¾,	3¼	3¼	3
Do. Preference	8,	9	—	—
Direct United States Cable	8⅞,	9⅛	9⅛	9
Eastern Telegraph	11¼,	11⅜	11½	11
Do. 6 per Cent. Preference	13¾,	14¼	14½	13⅞
Do. 5 per Cent. Debentures, 1899	106,	109	107¼	107⅛
Eastern Extension	11¾,	12¼	12	11¾
German Union	9¼,	9¾	10⅝	—
Globe Telegraph and Trust	5½,	5¾	5 11-16	5½
Do. Preference	13⅛,	13⅜	13 5-16	13 3-16
Great Northern	13⅛,	14	14	13⅞
Indo-European	36,	38	—	—
Reuter's	8,	8½	8⅜	8¼
Submarine	150,	160	151½	149
West India and Panama	1,	1¼	1 3-16	¾
Do. 1st Preference	9¾,	10¼	10 1-16	9 13-16
Western Brazilian	7¾,	8	8	—
Western Union 7 per Cent. 1st Mortgage	117,	123	120½	—
Do. 6 per Cent. Sterling Bonds	101,	104	—	—

TELEPHONES.

†Consolid. Telephone and Maintenance	9-16,	11 16	—	—
Oriental	¼,	⅜	—	—
United Telephone	11½,	11¾	11¾	11½
United River Plate	4½,	5	4 15-16	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	2,	2½	2⅛	2
Do. (fully paid)	3,	4	—	—
Swan	1¼,	1½	1 5-16	1¼
Maxim Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	37,	38	37¾	36¾
India Rubber, Gutta Percha and Telegraph Works	21,	22	21 7-16	21

* xd. and bonus. † Return of capital xd. 1s.

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THE ELECTRICIAN:

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NOTES.

It is interesting to note that as long ago as January, 1878, the possibility of using a condenser for increasing the output of an alternating dynamo was distinctly foreshadowed by Mr. Higgins (now of the Exchange Telegraph Company). In the course of a discussion at the Institute of Civil Engineers on a paper by Messrs. Higgs and Brittle, entitled "On some Recent Improvements in Dynamo-Electric Apparatus," Mr. Higgins made the following observations:—"But the power of the Alliance machine might be increased considerably, without adding to its bulk, by interposing in the exterior circuit a condenser of sufficient capacity. The discharge stored up in the condenser would pass back through the bobbins of the generator upon the fall and reversal of potential in the circuit, thus adding, without extra cost of machinery, to the quantity of electricity which the machine was capable of producing." It is needless to add that Mr. Higgins' suggestion is a perfectly valid one, and it probably would not have remained so long in abeyance but for the lack of a practical commercial condenser of large capacity.

The paper referred to in the above Note was, we have every reason to believe, well abreast of the science (and practice) of the times; but as an illustration of the enormous strides which have been made during the present decade, especially in the matter of "light effects," we may be allowed to quote the following extract:—

"The Best Use of Two Machines to Produce One Light.—From experiments made with the Gramme machine it has been found that, by coupling two machines in what is electrically known as parallel circuits, light effects are produced exceeding the sum of the light effects separately given by each machine."

This remark is followed by a table of experimental data.

The paper on Dr. Bernardo's system of electric welding by the carbon pencil, which will be found in another column (translated from our contemporary the *Elektrotechnische Zeitschrift*), seems to give promise of a most important future for this branch of the art. It would be rash at the present moment to offer any opinion as to whether this system or that devised by Prof. Elihu Thompson will ultimately prove to be the most advantageous. Probably each method has its own field. The transformer method has a distinct superiority in the fact that the heavy current is confined to a very short circuit, while with Dr. Bernardo's arrangement this is not the case, and the employment of a large number of accumulators, though clearly not an essential feature of the system, adds largely to its cost, and must lower its commercial efficiency. On the other hand, the employment of a continuous instead of an alternating current has evidently a great advantage in keeping the metal entirely free from oxidation. This is effected by making the metal take the place of the negative electrode. Another point in favour of the arc method arises from the fact that it is impossible in some cases to use the transformer method with its fixed electrodes in cases where tubes, or complete rings (such as boilers, &c.), are to be welded, inasmuch as the joint is short-circuited by the other side of the tube.

Since making our translation of the article referred to in the above note, we have received some direct information from Paris, where experiments of this nature have been for some time in progress at the Northern Railway Works at La Chapelle. We are sorry to learn that at present the results are not entirely satisfactory. Our correspondent writes:—"The weld is perfect; but a difficulty not yet mastered is that the fused iron is rendered porous, so that a tank electrically welded is not water-tight." We shall hope to learn that this difficulty has been effectually overcome, but at present it looks rather a formidable one.

A system of electric traction which is neither a secondary battery system, a conduit system, a conducting rail system, nor an overhead conductor system, certainly demands attentive consideration. If, furthermore, it should succeed in combining all the merits with none of the defects of these methods, we may venture to regard its future with some degree of hopefulness. Such a system we learn is now occupying the attention of Mr. Edison, who is busily engaged upon the first working models.

Meanwhile we are in a position to state that a system of the same or a similar character has already been devised in this country, and has already reached a stage of development considerably beyond that of "working models." Mr. Edison can so well afford to be forestalled in any single invention that we venture to hope that this intelligence will not give rise to any very severe strain upon his equanimity.

Mr. Edison, it is said, has given a large order in this country for nickel, with which he intends to construct a new type of pyro-magnetic generator. Probably no one capable of

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forming an opinion on the question will be greatly surprised to learn that he has abandoned the hope of turning the earlier form of the apparatus to practical account. He finds, we are told, that the iron plates disintegrate very rapidly under the action of the heat reversals. It is true that nickel loses its magnetic properties at the comparatively low temperature of 350°C., but it is very difficult to believe the statement that Edison seriously hopes to improve the commercial value of the apparatus by the substitution of nickel for iron, seeing that the cost of the two metals may be taken in the ratio of about 30 to 1. According to Rowland, *Phil. Mag.*, 1873 and 1874, the maximum intensity of magnetisation of the two metals at 12°C. and at 220°C. is as follows :—

	At 12°C.	At 220°C.	
Iron and Steel	1,390	1,360	C.G.S. units.
Nickel	494	380	„

A pyro-magnetic generator built of nickel appears to us a rather fantastic conception.

THE Council of the Society of Telegraph-Engineers and Electricians has once more under its consideration the question of amending the style and title of the society and of increasing the frequency of its meetings. We sincerely trust that it will see the way to adopt both suggestions. We need hardly say that we shall be amongst the first to welcome any step which may tend to increase the influence or extend the usefulness of the society.

WE fear that the Gas Commissioners of Massachusetts must have been not a little perplexed by the contradictory nature of the scientific evidence laid before them by Prof. W. D. Marks on the one hand, and by Mr. W. F. Jenks on the other. They had under consideration the relative efficiency of distribution by transformers, and by the Edison direct system of supply. The learned professor put down for the alternating system an economy (? efficiency) of 56 per cent., allowing 70 per cent. for the dynamo, and 80 per cent. or less for the transformer, crediting the conductors, apparently, with 100 per cent. efficiency. But the Edison system up to two-thirds of a mile yields, according to this authority, "an economy from 60 to 100 per cent. greater." 100 per cent. greater than 56 per cent. is, we take it, 112 per cent., which is indeed something like "economy." But the learned Professor did not really mean this, for we find elsewhere that he puts down the Edison system at a modest 85 per cent. Now, however, comes Mr. Jenks (one of the engineers of the Edison Company) upon the scene, and it is distressing to a well-regulated mind to learn that a mere practical engineer should have presumed to differ from a Professor of pure and [mis]applied science. However, according to this gentleman, the average illumination obtained by customers of the Edison Company at Brockton was 120 candles for every horse-power developed at the central station when direct currents were supplied, while the company were prepared to guarantee as much as 160 candles on the alternating system.

IT is not a difficult matter to determine by calculation what should be the efficiency of an alternating system. The dynamo may be taken at 87 to 90 per cent.; add 3 per cent. of the output for the energy spent in exciting, and we get 630 watts for every horse-power developed. The mains must evidently be of so low a resistance as to make the drop of pressure insignificant, whilst a loss of 10 per cent. in the feeders will in most cases be an ample provision. This reduces the energy received at the primary terminals of the transformers to 567 watts. The efficiency of modern transformers can safely be reckoned at 95 per cent. at full and 85 per cent. at quarter output, or 90 per cent. average. Thus 510 watts will be available for the lamps for each actual horse-power developed at the station. With the liberal allowance of 3¼ watts per candle, this gives 158 candles to the consumer, so that the statement of Mr. Jenks is very near the mark, and his company should have no difficulty in giving the guaranteed illumination per horse-power.

FROM a letter in another column the world at large will learn that there is at length a prospect of the vexed question of primary battery lighting undergoing a serious development. We are sure that the advocates of other types of battery cannot afford to overlook the challenge of Mr. W. Webster, jun., who not only stakes his professional reputation on the merits of the Holmes-Burke type of cell, but adds a substantial sum in cash (to be paid to some deserving object). This looks like business, and we shall be most happy to render any assistance in our power to facilitate the competition. We have a convenient cellar for the batteries, and upon certain conditions we should be quite willing to allow the test to take the form of lighting the offices of this journal. We can take about fifty 20 candle-power lamps.

IT must be admitted that Mr. Wm. Webster, jun.'s, confidence in the Holmes-Burke cell rests upon the foundation of practical trials on a more extensive scale than those of any other battery for electric lighting now in the field. In five cases we could mention these cells have been employed for two years and upwards, and there are a good number in use which have been at work twelve months and under. The Eastern Telegraph Company have several of these batteries in use in their foreign stations, and we understand that they are giving satisfactory results.

IMPLICIT belief in one's own ideas is a good thing, no doubt, but it does not necessarily entitle a man to a reward of £500. Mr. Walsh, of Eclipse battery fame, however, evidently thinks otherwise. In a letter to *The Times*, referring to Mr. O. Lever's offer of a reward for a portable lamp, he says :—"Then I said to him (Mr. Kelly), 'that I had not got the slightest doubt that I would receive the £500 award.' He said, 'I hope you will—there is no doubt about it, you have got implicit belief in your invention.'"

WE take it that Mr. Walsh will certainly accept Mr. William Webster, jun.'s challenge, and then possibly we may see Eclipse first and the rest nowhere.

ANYBODY can quote scripture; but not everybody can play the characters well. One of our contemporaries, taken to task by a correspondent of another contemporary for claiming

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to have originated the idea of an Electrical Association, and dropping it when it approached realisation, has retorted by insinuating that its critic is one of the unemployed seeking a berth in the new scheme! Assuming the prophetic mantle the aggrieved journal proceeds to say that "if we placed our hand upon the shoulder of him we suspect of being the author of the letter, and said unto him, 'Thou art the man,'" &c. Really, this is playing Nathan very ill. He did not put his hand on the king's shoulder, for that would have been a breach of good manners; he simply touched the offender's conscience, which is precisely what our irate contemporary fails to do. We have it on good authority that the writer of the letter was and is fully employed, and not at all anxious to add to his labours. In other words the prophet's pen has prophesied falsely, and the journalist's hand has fallen on the wrong man's shoulder.

OUR own concern in this matter leads us to make the further observation that it was David, not Nathan, who wrote saying, "Set ye Uriah in the forefront of the hottest battle, and retire ye from him that he may be smitten and die." Now, this is the *rôle* our retiring friends have been playing pretty well, and we make no complaint; but they cannot do that and the prophet all in one, with the part of Uriah and his ewe lamb thrown in.

PROBABLY most of our readers will feel a sensation of relief on learning that one of the most serious of the several law-suits with which the electrical engineering profession has recently been threatened is already settled out of court. We refer to the suit of the Anglo-American Brush Company in support of their claim on compound-winding. It may be remembered that in a supplement to *The Electrician* of October 2nd, 1885, dealing with the Brush Corporation's apparatus then to be seen at the Inventions Exhibition, Mr. Mordey gave a "characteristic" of a small Brush electro-plating dynamo constructed in the United States nine or ten years ago, which showed that Mr. Brush had thus early succeeded fairly well (considering the period and the character of the results at that time obtainable with even the best dynamos) in obtaining constant E.M.F. The general idea has been that Brush's object was simply to prevent currents from plating baths causing reversal of the polarity of dynamos. This result is no doubt obtained in compound machines, even if they are stopped while connected to the baths, if the series field winding is not too great, especially where cast iron magnets are used. But that this was not Brush's only object—that he wished to obtain constant E.M.F. in addition—was clearly shown in the article referred to, where attention was drawn to the fact that in the patent specification (No. 2003 of 1878) it was explained that a further purpose of the double winding was to enable the dynamo to do either a large or small amount of work. That is to say it was to deposit equally well on the articles in the bath whether those articles were large or small in number or in extent of surface—in other words, whether the current was great or small. That these conditions are "constant potential" conditions such as are usually aimed at in modern compound dynamos cannot be disputed; nor need it be explained that what applies to a plating vat, where all the articles were connected parallel, applies equally well to a circuit of incandescent lamps connected in the same manner—a method of electric lighting which, as a matter of fact, has been developed since the date of the compound-winding patent. It may be added that the patent is also of earlier date than the invention of the simple shunt-wound dynamo. That other uses than that of electro-plating would be found for this method of winding was indeed obvious, and was not lost sight of in the specification alluded to. We think that we are justified in regarding the final decision which the parties to the suit have had the good sense to arrive at as a fair and equitable one; and we congratulate the Brush Corporation on having obtained a recognition of its rights without the necessity of going into the courts.

HUMAN beings of the hum-drum common-place type have reason to be envious of the absolute confidence with which more highly-gifted mortals are able to regard their own achievements both present and prospective. How pleasant it must be, for instance, to be able to think and talk like this (we quote from an interview between a reporter of the *New York Herald* and a certain distinguished American electrician, whose name we shall forbear to disclose):—"I have solved the question of travel by electricity," said Mr. ——, "and I am now building an experimental [Why experimental ?] motor. There will, of course, be improvements in devices, but there is nothing further to be done in principle. That is complete, and leaves no question that we can travel between New York and Philadelphia, drawn by an electric motor, as rapidly and safely as by steam-power, and more cheaply. There is no guesswork about my assertion. It is so certain that I stake my professional reputation on having the trains running as soon as the patents are granted, the roads ready to make the experiments, and the motors built. Of course I cannot now make public the principle, but I may say that it differs from any of the existing methods of operating electric motors on railway lines. It is not merely a scientific possibility, but a practical, commercially available and economical solution of the problem of electric railway motors."

Tenders Wanted for Telegraph Stores.—In another column will be found an advertisement of the North-Eastern Railway Company, who are asking for tenders for the supply of Telegraph Stores.

The Channel Cables.—The Paris *Temps* denies the rumours circulated by the *Central News* with regard to the Submarine Telegraph Company's cables. According to the *Temps* the French Government have not yet renewed the concession, and consequently the English Government have not vetoed it.

Conversazione of the President of the Society of Telegraph-Engineers and Electricians.—The President of the Society of Telegraph-Engineers and Electricians and Lady Bright have issued invitations for a *conversazione* to be held on the 15th December in the Galleries of the Institute of Painters in Oil Colours, 191, Piccadilly.

The Electro-Harmonic Society.—The next meeting of the Electro-Harmonic Society will take place at St. James's Hall Restaurant (banquet room), at eight o'clock, on Friday, the

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2nd December. This is a "ladies' night," and the programme arranged for appears to be fully up to the usual high standard of excellence of these enjoyable evenings.

Electric Light in Warfare.—It is a well-known military maxim that the side which first gets frightened loses the battle. In savage warfare the electric light is evidently capable of rendering excellent service in this direction. Witness the Reuter's telegram describing the terror of the Yonnies at the glare of the search lights during the recent fighting in Sierra Leone.

Clerkenwell.—Mr. J. W. King, of St. John's-square, informs us that he has lit his new gilding and plating works by electricity. The plant consists of an Edison Z type dynamo and a battery of Elwell-Parker accumulators. In his plating works he employs an Elwell-Parker and a Crompton-Bürgin converted machine, supplemented by various sets of accumulators. Motive power is derived from an Atkinson gas engine.

"The Electricians' Directory."—We shall be very pleased to receive from our readers any suggestions as to tables, &c., which might usefully be inserted in the forthcoming issue of "The Electricians' Directory," which will be ready at the end of December. This issue will be considerably larger than its predecessors, and suggestions of any kind for the improvement of the editorial portion will receive careful consideration.

Physical Society.—At the meeting of the Physical Society to be held at the Science Schools, South Kensington, on Saturday next, at three p.m., a paper will be read by Prof. S. P. Thompson, "On the Analogies of Influence Machines and Dynamos," and Mr. H. Tomlinson will read a paper "On the Thermo-Electrical Properties of Iron, when under Stress or Strain, by Raising the Temperature to a Bright Red."

The Electric Lighting of Trains in Germany.—Upon the Stuttgart-Hall Railway experiments are now being made in train lighting by means of Khotinsky accumulators and Bernstein lamps. A second battery is provided, which is being charged while the first is running down. The dynamo is driven from the axle of the guard's van, provision being made for automatic switching off when the speed falls too low.

The Edison Central Stations in America.— A New York journal gives a detailed list of 103 central stations in America which are equipped with Edison plant. The total number of lamps supplied from these stations is 313,300. Two stations (New York and Philadelphia) supply 15,000 lamps each, and there are half-a-dozen supplying 10,000 lamps, while the number with less than 1,000 lights is comparatively small.

Gas Engines employed in a Central Station Plant—At Spencer, Massachusetts, a Ball arc-light plant of 60 lamps is run entirely by gas engines. Three Otto engines, of 15 nominal horse-power each, are used. The plant is owned and worked by the local gas company, who thus manage to keep the business of lighting the town in their own hands, while utilising their own product. Very favourable reports are made of the successful and economical performance of the system at Spencer.

Settlement of the Action re Compound-Winding.—The important "compound-winding" action on the Brush patent, brought by the Anglo-American Brush Electric Light Corporation (Limited) against Messrs. Crompton and Co. has been settled. Messrs. Crompton have accepted the usual license, and agreed to judgment in favour of the corporation. The cross action brought by Messrs. Crompton on the Crompton-Kapp patent has been withdrawn, the Brush Corporation taking an assignment of that patent.

Taunton.—A deputation consisting of the local authorities of Weston-super-Mare recently visited Taunton for the purpose of viewing the electric light arrangements. They inspected the lighting of the streets, paid a visit to the engine room, and afterwards went to St. James's Church, which is illuminated with electricity. At five o'clock they partook of tea at the Castle Hotel, under the presidency of Mr. T. Penny, in the absence of the Mayor (Mr. S. Farrant). Speeches of a congratulatory and practical character were made, and the deputation expressed themselves greatly pleased with their visit.

University Extension Lectures.—The first of the series of lectures to be delivered by Mr. Lant Carpenter, at the Shoreditch Town Hall, under the auspices of the London Society for the Extension of University Teaching, and of the Gilchrist Trustees, was given on Monday last, the chair being taken by Prof. Stuart, M.P. The subject of this series is "Electricity in the Service of Man," illustrated by experiments and by the oxyhydrogen lantern, and the admission fee is one penny. The hall was filled with an enthusiastic audience of over 1,200 persons, and there can scarcely be any longer a doubt that the experiment is likely to be a highly successful one.

The Transmission of Power in India.—The *Times of India* contains a description of a remarkable engineering undertaking at Gokak, where three turbines, each of 250 horse-power, transmit power by rope gearing to a cotton mill at a distance of 739 feet, the first 300 feet being up the face of a perpendicular cliff. The work appears to have been carried out in an especially skilful manner. If we mistake not, this is the enterprise about which some correspondence took place in our columns with regard to the feasibility of electrical transmission. We should have been glad if the engineers had seen their way to this, but it must be confessed that a scheme of such magnitude would have presented a stiff problem to electrical engineers.

National Telephone Company's Conversazione at Glasgow.—The seventh annual *conversazione* of the *employés* of the National Telephone Company and their friends took place on Friday last in St. Andrew's Halls, Glasgow. Colonel R. Raynsford Jackson, chairman of the company, presided, and he was supported by Sir William Thomson, Mr. J. L. Mitchell, Mr. Wm. Alexander Smith, resident director; Mr. D. Johnstone Smith, district secretary; and Mr. Daniel Sinclair, resident engineer. During the proceedings a short speech was delivered by Sir William Thomson, who paid a high tribute to the National Telephone Company, remarking that he was not overstating the case when he said that the telephone had turned out as well in Glasgow as in any other place in the world, and it was better by far than in any other place of which he had personal experience.

A Foucault-Current Water-Heater.—One of the American companies has brought out an electric water-heater for use with alternating currents. It consists of an ordinary kettle having a rather thick bottom. When this is placed above an electro-magnet supplied with alternating currents, heat is produced by the generation of Foucault currents in the substance of the metal. This arrangement has some obvious advantages over the method of placing a resistance coil within the metal, but it is difficult to imagine that it can be equally efficient. A theoretical comparison of the amount of heat obtainable for a given expenditure of energy by the two methods would be interesting. It is useful to remember that 1,000 watt-hours is capable of raising 19·04lb. of water from 0°C to the boiling point, or of completely evaporating 2·95lb. of water from 0°C.

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Glasgow College of Science and Arts.—The following excellent results were announced by Prof. Jamieson at the distribution of prizes which took place last week at the Glasgow College of Science and Arts:—The John Pender Gold Medal, or £5. 5s., for the best electrical engineering student taking the College diploma in electrical engineering, was gained by Jas. Raeburn, jun., now in Buda-Pesth, Austria. Eight students passed the technological examinations in electricity of the City and Guilds of London Institute. Of these one student took a prize of £5 and a silver medal in electric lighting; two students took a prize of £5 and a bronze medal, one in telegraphy, and one in electric lighting. Three took first-class honours in telegraphy, and the same number in electric lighting. Two gained second class honours in the latter subject. Numerous prizes and certificates were taken by students of the above College in mechanical engineering (City and Guilds of London Institute's examination) and in chemistry, practical geometry, naval architecture, machine construction, &c. (the Science and Art Department).

An Electric Type Writer.—We learn from a New York paper that considerable importance is attached to the appearance of a new instrument which is to compete at the same time with the mechanical type writer and with the telephone. The apparatus employs electricity as a motive power for actuating a type writer, which seems in other respects to bear a close resemblance to the instruments of ordinary construction; but by introducing electricity as an intermediary it is claimed that great evenness of action is secured, irrespective of the weight with which the keys are manipulated. The motion to and fro at the end of the lines is also purely automatic. But in addition to its use as a type writer the same instrument can also be employed both as a transmitter and receiver of telegraph messages. The receiving instrument does not require the attendance of an operator, but prints the despatch automatically. The instruments at both ends of the line print the despatch sent, and so a safeguard against mistakes is provided. It is claimed that the electric type writer will be valuable as a local aid to business, and offers many advantages over the telephone. One advantage claimed for it is that, no matter whether a person called up is at his place of business or not, the message can be printed through the medium of his type writer, and will be there for perusal on his return The despatches printed are in letter form, and not on endless tape. The instrument has been christened the "dynamograph."

Watt Arc Lamp is this?—We take the following paragraph from an esteemed contemporary, the *Bullionist*:—"On the invitation of the chairman (Mr. Hugh Watt, M.P.), we, on the 18th inst., visited the works of the Maxim-Weston Electric Company to witness in operation a small arc lamp, by means of which Mr. Watt claims to obtain five times the subdivision of light hitherto achieved by means of arc lighting. The lamp in question requires from 2½ to 3 amperes and 40 to 45 volts, giving about 150 candle-power. It will thus be seen that at least six lamps of this power can be obtained from one electrical horse-power. The invention consists in the arrangement of a series of wheels, levers, or other form of gearing for multiplying purposes, constructed on holders, frames, or bearings, so that the mechanism shall be held in check by means of a brake placed in a part of the electrical circuit, so that the carbons, when burning, are perfectly controlled. In other words, the lamp is so constructed that, when working, the current of electricity shall pass through the brake in such a manner as to show in and out of circuit, wholly or partially, the current; and, further, that the percentage of resistance shall be such as to prevent an undue shortening or elongation of the arc. Mr. Watt claims that by this means a steadier light will be obtained than by any known arc lamp; and also that the difficulty hitherto experienced in the lighting of large open or enclosed spaces, viz., the question of distribution at a low rate per lamp, will be overcome. He estimates that a large complete installation of the 'Watt' dynamo and lamp will not cost more than one half-penny per lamp per hour, while the present arc lamp costs something like five times that amount. Should the lamp in question answer the claims put forth regarding it, which it certainly seems to do, there is no doubt that it will tend in a very large degree to overcome the difficulty which has prevented our towns and cities being lighted by electricity on a large scale as in America, namely, the question of cost. The lamp, which will be known as the 'Watt' lamp, and the new 'Watt' dynamo from which it will be run, Mr. Watt claims are both in advance of any invention in this branch of electric lighting; and he further informs us that he hopes to be in a position to supply complete installations by 1st January next. The first batch of lamps are now in course of construction by this company."

The West India and Panama Telegraph Company.—*The Statist* explains the proposed scheme of reconstruction suggested at the meeting last week, and now under the consideration of the directors, as follows:—"The proposal is to cancel the £38,019 First Preference dividends overdue by an issue of like amount of First Preference capital, equal to £1. 2s. per share. The Second Preference capital and the accrued dividends on it are to be cancelled, and First Preference shares given instead in the proportion of 75 per cent., or £7. 10s. per share, in exchange for each £10 Second Preference Share and the dividends overdue thereon. The practical application of the scheme, it is explained, would be:—

First Preference.—Shareholders would receive per share an additional capital of £1. 2s. The present shares are quoted	£9	5	0xd
Valuing the reconstructed capital at £9 per £10 Share (to be within the mark), £11. 2s. capital would be worth	10	0	0
Showing an immediate increase in value per share of	0	15	0

On the basis of the dividends paid for the past year, it would take over seven years to liquidate the amount now overdue on the First Preference Capital.

Second Preference.—The price of these shares is nominally..	£6	0	0
In place of the present £10 Share and the accumulated dividend, holders would receive £7. 10s. First Preference Capital, which at £9 per £10 share would be worth	6	15	0
Showing an immediate increase in value per share of	0	15	0

No distribution has been made on the Second Preference capital for the past seven years and a-half, and as the company has, during the past twelve months, paid only one excess dividend of 3s. per share to the First Preference, and there still remains a sum of 22s. per share overdue, it follows on this basis that the holders of Second Preference Shares would not receive any dividend for the next seven years, until the arrears on the First Preference were liquidated. By the scheme proposed each £10 Second Preference Share would be exchanged for a freely marketable security now earning a dividend of 9s. per annum." We have reason to believe that there are legal difficulties in the way of carrying out this suggestion.

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THE RISE AND PROGRESS OF TELEPHONY IN THE UNITED KINGDOM.

(Continued from page 533, Vol. XIX.)

At the close of the previous chapter it was mentioned that at the trial of the United Telephone Company *v.* Harrison, Cox-Walker, no serious attempt was made to show that the Reis transmitter interfered with the Edison patents as amended by the disclaimer of platinum contacts. It was otherwise with the contention that Philip Reis had anticipated the inventions of Graham Bell; on this issue the fight waxed hot and furious, and there are those who to this day contend that the judicial decision was not consistent with the facts of the case.

The learned judge had no difficulty in arriving at the conclusion that the "first Reis," as it was called (that is, the instrument consisting of a knitting needle surrounded by a coil, and placed upon a sounding board), could not be held to have anticipated the Bell receiver. The magnetic diaphragm which is the essential feature of the latter instrument is entirely absent from the former, and the alleged anticipation was held to have failed.

But the instrument upon which the defendants based all their hopes of upsetting the patents was the so-called "second Reis," which was illustrated and described in our last chapter, and which consisted of an electro-magnet with a bar armature held off by a spring, and carrying a wooden lath to reinforce the sonorous effect of its vibrations. Whether this bar armature did or did not constitute an anticipation of the diaphragm armature of Bell was the vital question at issue.

Before coming to a decision upon this point, however, the learned judge had first to consider the question whether or not "prior publication" had taken place in this country. It is generally understood that to invalidate a patent it is not sufficient to prove that the same discovery has been made at an earlier date, it must also be shown that knowledge of the invention had become public property. It has already been explained that our knowledge of "the second Reis" is solely derived from an illustrated description in the *Zeitschrift* by V. Legat (of which a full translation appears in Prof. Silvanus Thompson's book). No evidence exists, however, to show that this paper had been translated into the English language at the date of the trial, but it was proved that copies of the *Zeitschrift* had been filed in the usual way at the Patent Office Library, and in the Library of the Institute of Civil Engineers. Nevertheless, the only person who could be discovered in this country to have known of the existence of this paper was Dr. Muirhead, who seems to have made a careful examination of the contents. It may be worth while to mention that after the conclusion of the trial a correspondent writing to a contemporary journal called attention to what he believed to be a curious oversight on the part of the defendants, inasmuch as a description of Reis's telephone receiver appeared in the 1867 edition of "Ferguson's Electricity," pp. 257, 258. As a matter of fact this appearance had not been overlooked, as it is mentioned in the defendant's "particulars of objection;" but the instrument described by Ferguson is the "first Reis" and not the one described by Legat. This is perhaps a small matter, but as a mis-statement of a point of some importance it is as well not to allow it to go uncorrected.

The learned judge found some difficulty in construing the law as to what constituted prior publication, but eventually, "though not without some doubt," he decided that Legat's paper "must be considered to have been within the knowledge of persons skilled in these matters in this country." The way was therefore cleared for the more important question as to whether the Reis had anticipated the discovery of Bell. The judgment proceeded as follows:—"Looking at the plates it appears to me to be plain that the armature in Reis's receiver was not a disc at all, it was not a plate at all, but that it was a beam—a solid bar. When I say solid I do not mean that it was rectangular. It appears to me to have been a bar whose section was oval, and that is the result which is conveyed to my mind by the plate, and I think that the model which has been exhibited before me, in which that bar is converted into a twisted or curved disc, does not really and truly represent the instrument as described by Reis. I think, therefore, that the criticisms of Sir Frederick Bramwell on that model were perfectly well founded, and that there was nothing in the Reis which can be considered to have been an anticipation of the armature of the description indicated in Bell's patent. No doubt Reis's invention is coming near to the invention which was afterwards made by Mr. Bell, but it appears to me not to be the same; and I am not at all convinced that it will operate in the same way. It is perfectly true that there is some evidence before me that Reis's instrument will speak, but it does not appear to me that there is any evidence which shows that it could be made successfully to speak before Mr. Bell's patent was made known; and it is obvious that the advances which have been made in telephonic science, very largely in consequence of his discoveries, have enabled persons to use instruments in a manner which neither their inventors nor their users could have used them before the discovery; and I think this must be further borne in mind, that instruments as little like the true Reis as the ones that have been exhibited would, I have no doubt, apply within the description of Reis's instrument as being universal instruments."

(To be continued.)

ELECTROLYSIS OF IRON SALTS.

BY ALEXANDER WATT.

(Continued from page 7.)

It was noticed in the last paper that solutions of the perchloride and persulphate of iron yielded no deposit of metallic iron upon the cathode. It was next determined to ascertain the behaviour of a solution of the pernitrate of iron, employing the liquid at various degrees of concentration, with a current from two to five small Daniell cells progressively, the cells being arranged in series. The anode, as in the former cases, consisted of a plate of wrought iron, and the cathode a strip of sheet copper.

Pernitrate of Iron.—A concentrated solution of this salt was prepared by digesting fragments of iron in a solution composed of equal parts of nitric acid and water. On the following day the solution was ready for use. To form the electrolyte, for the first trial, five fluid drachms of the pernitrate solution were added to five ounces of water. Two Daniells were used, and the electrodes then immersed, their surfaces being about equal. During the first few seconds no apparent deposit took place, so the cathode was moved about quietly, when a slight film of iron began to form. The plate was then allowed to rest for about two minutes, at the end of which time it became coated with a thick black deposit, interspersed with bubbles of hydrogen, which rested firmly on the plate. Surrounding these gas bubbles were minute glistening particles of metallic iron, which had evidently been reduced by the hydrogen. The plate was now carefully rinsed so as not to disturb the coating, and was then held over the flame of a small lamp, at a moderate distance from the flame, until the black deposit became dry on both sides of the plate. During the process of drying, the deposit suddenly broke up into minute particles, leaving the copper surface exposed. The particles were then brushed off and collected upon a piece of white paper. Upon holding a magnet below the surface of the paper the granules were powerfully attracted, proving that they consisted of metallic iron in a very finely-divided state. A second plate was then immersed in the bath and allowed to rest for about five minutes, by which time it became very thickly coated with the same black deposit, which was afterwards washed, dried, and collected as before. An attempt was next made to induce the metal to deposit in a reguline form, by diluting the solution considerably. In this case, as before, a slight reguline film appeared upon the copper plate when it was kept in motion, but so soon as it was allowed to remain stationary the black deposit again formed, and after a few minutes' immersion it stripped off the plate (doubtless

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dislodged by the hydrogen bubbles) and accumulated at the bottom of the vessel. The black deposit was afterwards collected, washed and dried as before, and the resulting black dust tested with the magnet, by which it was powerfully attracted. A still weaker solution was next tried, with a precisely similar result, and the plate was allowed to remain in the bath for about ten minutes, during which time the black deposit from the cathode accumulated on the surface of the liquid, nearly covering its entire surface in fact, the fine particles of iron being held in suspension by the hydrogen bubbles, with which it was intimately mixed. The solution eventually became nearly colourless, while the anode was but slightly acted upon. It should be mentioned that the evolution of gas was much more copious with the weaker than with the stronger solutions, while in some cases bubbles of gas nearly as large as a pea rested upon the plate for at least a minute before bursting. In reflecting upon the character of the dried deposit of iron above described, it appears to me to resemble the pharmaceutical product known as *Querenne's Iron*, which is prepared by passing a stream of dry hydrogen gas through red hot sesquioxide of iron contained in a gun barrel, the object of which is to reduce the iron in a very finely divided state, by which it may readily become dissolved by the juices of the stomach, thus forming a useful and effective chalybeate. The formation of *impalpable metallic iron* in the way I have indicated would be a far cheaper and less troublesome method than either of the processes adopted for preparing Quevenne's iron; indeed, I am disposed to think that the iron could be produced in a more finely divided state electrolytically than by the pharmaceutical methods.

Citrate of Iron.—A solution of this salt was prepared by dissolving recently-precipitated carbonate of iron in a moderately strong and hot solution of citric acid, the carbonate being added a little at a time until evidence of neutralisation occurred, which became known by the liquid remaining turbid after the last addition of the iron salt was made; an excess of citric acid was then given, not only to clear the liquid, but to assist the solution of the anode. The solution was used cold, and two small Daniells at first employed. A clean strip of sheet copper received a white and bright deposit of iron soon after the immersion, but as the deposit was scarcely rapid enough, a third cell was connected, when deposition took place freely upon a newly-prepared plate. After two hours' immersion a good bright deposit was obtained, which thickened at the lower edges in the form of minute nodules. The film, which was of a silvery whiteness, was of a thoroughly reguline character, excessively hard, and readily attracted by the magnet. On examining the anode, it appeared to have been very freely and uniformly acted upon. Five cells were next tried, when the deposit became more rapid, but still maintained its bright and silvery lustre, being even whiter than the best Damascus steel.

Cyanides of Iron.—The various cyanide salts of iron were tried, but not one of them yielded a reguline deposit of the metal. The only solution of this class which gave a tolerably successful result was that of the sulphocyanide of iron, from which a darkish film, of an iron-grey colour, was obtained upon a copper plate by keeping it continually in motion; no deposit appeared to take place upon a stationary electrode. While deposition was going on under these conditions a dirty white deposit formed upon the anode which was insoluble in the liquid.

Sulphate of Iron and Chloride of Ammonium.—A solution of the mixed salts has been applied by Meidinger and others for coating copper plates with iron. For this purpose the following proportions give very satisfactory results:—Sulphate of iron, 2oz., dissolved in water 1 pint; sal ammoniac, 1¼oz., dissolved in water 1 pint. These solutions were mixed, and a few drops of acetic acid added. With the current from two Daniell cells, and electrode surfaces about equal, a reguline deposit of iron was obtained upon a copper plate from a bath prepared as above immediately after immersion. There was but moderate evolution of gas, and the film was exceedingly uniform and of good colour, though neither so bright nor so purely white as the deposits from the simple sulphate or citrate salts. After half an hour's immersion, the coating, though otherwise faultless, assumed a dull appearance; there was no blackening at the edges of the plate, however, nor any other irregularity of the surface of an objectionable nature. There was a slight deposit of peroxide, however, which would doubtless continue to form, but since this readily finds its way to the bottom of the vessel it does not necessarily interfere with the film, provided the liquid be kept in a deep vessel and the deposited oxide allowed to remain undisturbed when immersing or withdrawing the coated plates. On examining the anode (a plate of wrought iron) it appeared to have been pretty uniformly acted upon, and exhibited the characteristic crystalline appearance of iron which has been subjected to the solvent action of weak acid solutions. The deposit upon the cathode, after one hour's immersion, had become somewhat more dull, but otherwise the coating was perfectly uniform and of good quality.

Protacetate of Iron.—A solution of this salt was prepared by dissolving freshly-precipitated carbonate of iron in dilute acetic acid, of which it is a ready solvent. The carbonate of iron was added in moderate quantities at a time, until the acid became neutralised, when a small addition of free acetic acid was made, and the bath, after filtering, was ready for use. The current from three small Daniells was employed, and the surface of the positive electrode was about three times that of the cathode. Under these conditions a good white deposit was promptly obtained, the film being of a perfectly reguline character. After a short immersion of the electrodes the anode was examined, and proved to have been freely acted upon. There was a slight disposition for the deposit to blacken in the centre of the negative plate, which was remedied by immersing a larger surface of anode. The deposition was now allowed to proceed undisturbed for about two hours, at the end of which time it was found that the solution had become considerably oxidised, there being a copious deposit of peroxide of iron at the bottom of the vessel; at the same time the deposit had lost its reguline character, and became black and pulverulent, while the anode was considerably eaten away.

Sesquiacetate of Iron.—A solution of this salt was prepared by dissolving freshly-precipitated hydrated sesquioxide of iron in acetic acid, the solution being afterwards moderately diluted and filtered. There was practically no deposit obtained from this solution, even when brisk motion was given to the cathode.

Ammonio-Chloride of Iron.—A bath was prepared by adding to a solution of perchloride of iron another of chloride of ammonium, the combined liquids being of moderate strength. Five cells were used, and a large anode surface exposed. On immersing the negative plate (a strip of copper) it received a partial coating of a dark colour, but while the plate was stationary in the liquid there was practically no deposit. When the plate was briskly moved about a slight film appeared all over the immersed surface, which was black at the lower corners; beyond this there was no deposit obtainable. The solution was next diluted with a considerable proportion of water, when the plate became coated with a black film of iron in a finely-divided state, similar to that obtained from the pernitrate, but much more slowly formed. The results, however, had no practical significance.

Oxalate of Iron.—A solution was formed by dissolving freshly-precipitated carbonate of iron in a strong solution of oxalic acid. The iron salt dissolved very freely, with evolution of carbonic acid, leaving a clear solution, which was next diluted with water. With two Daniells no deposit took place upon a copper cathode while it remained stationary in the liquid; when this electrode was briskly moved about, however, a white film of iron was obtained, which gradually increased in thickness so long as the agitation was kept up. During the electrolysis the solution became decomposed, and a deposit of peroxide settled at the bottom of the vessel. Five cells were also tried, but there was no deposit of reguline metal unless the cathode was kept in brisk motion.

Ammonio-Citrate of Iron.—A solution of this salt was prepared by first dissolving recently-precipitated carbonate of

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iron in a strong and hot solution of citric acid; the solution was then allowed to cool, when liquid ammonia was added, and the solution was then ready for use. With the current from five small cells a copper plate received a bright silvery deposit of iron immediately after immersion, and maintained this character for some time; but, owing to the anode not becoming freely dissolved, the solution eventually yielded its metal very slowly.

Ferrate of Potassa.—A deposit of iron may be obtained from a solution of this salt, by using a moderate current, but the liquid soon decomposes with the formation of peroxide of iron.

Sulphate of Iron and Sulphate of Magnesia.—For obtaining electrotypes of iron, MM. Jacobi and Klein first deposit a film of copper upon lead or gutta moulds in the usual way, and after well rinsing they are at once placed in a bath composed of sulphate of iron 139 parts, sulphate of magnesia 123 parts. These are dissolved together in hot water, and a little oxalic acid, as also some iron shavings added. The solution is kept in a well-stoppered bottle or carboy, in its concentrated state, and when required for use is diluted with water until its solution has a specific gravity of 1·155 (water being 1,000). In working this solution oxide of iron forms on the surface of the liquor, which must be skimmed off with some of the solution and shaken up in a bottle with a little carbonate of magnesia, and after settling the clear liquor is returned to the bath. The iron deposited from this bath is very hard and brittle, therefore the electro deposit must be carefully handled when separating it from the mould. The copper is removed from the surface of the electrotype, either mechanically, or by dipping it in strong nitric acid.

Ferrocyanide of Iron.—The following solution, devised by Boettger, for coating engraved plates, is probably the only cyanide preparation of any practical value:—Ferrocyanide of potassium 10 grammes, Rochelle salt 20 grammes, are dissolved in 100 cubic centimetres of distilled water. To this is added a solution composed of persulphate of iron 3 grammes, dissolved in 50 cubic centimetres of water. A solution of caustic soda is next added, drop by drop, with constant stirring, until a perfectly clear liquid is obtained of a light yellowish colour. This solution, which would have little action upon an iron anode, would require to be constantly strengthened by the addition of concentrated liquor.

(To be continued.)

LETTERS FOR LEARNERS AND NON-PROFESSIONAL READERS.

By A. E. Kennelly, Electrician, Eastern Telegraph Company.

Chapter II.

Batteries.

(Continued from page 31.)

11. In the Daniell cell the difficulty of polarisation is overcome by surrounding the copper plate with a solution of sulphate of copper, so that the hydrogen at the moment of its development, instead of accumulating on the surface of the plate, attacks this copper sulphate, turning out the copper, which deposits on the plate as a metallic layer, and chemically takes its place, forming hydrogen-sulphate—*i.e.*, sulphuric acid. The plate is thus kept clean during the action of the cell by the addition of pure metal, while the sulphate of copper is consumed and the solution acidulated. Under these circumstances scarcely any polarisation (*see* para. 10) takes place, and the E.M.F. of the cell is nearly constant under every rate of current supply. It is convenient to remember that the volt (*see* para. 4) is approximately the E.M.F. of one Daniell cell. Even with care in the choice of pure materials and in the strengths of solutions, differences of as much as 2 per cent. will be found in the E.M.F. of a series of cells, but the average under most favourable conditions is 1·08 volt each.

12. This cell's chief disadvantage lies in the fact that zinc, like hydrogen, decomposes copper sulphate, forming zinc sulphate and throwing out the copper. If, therefore, any of the copper sulphate solution reaches the zinc plate it is immediately converted into zinc sulphate, and the copper is thrown down upon the plate. Each separate particle of copper so deposited sets up by contact with the zinc plate a separate E.M.F., by which a local current is established, flowing from the particle through the area of contact to the plate, and from the plate back to the particle through the

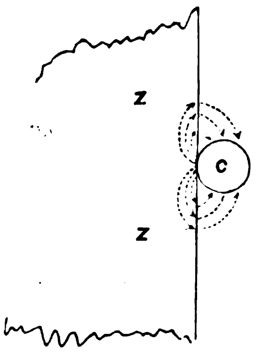

Fig. 2.

surrounding solution, as shown in Fig. 2, which gives a magnified representation of such a particle, C, on the surface of the plate Z. This local current continues as long as the contact between Z and C is maintained, and the zinc in the vicinity of the particle is consumed, while the main current of the cell, receiving no accession through this source, is rather impeded by the obstacle C. This local current, decomposition, and wasted consumption of zinc is termed *local action.* It is clear that any metallic impurity in the zinc plate, and at its surface of contact with the solution, tends to set up local action; and a plate of zinc containing such impurities consumes irregularly in action, and will show signs of pitting after merely remaining plunged in water for some time. Local action due to metallic impurity may be got rid of by cleansing the zinc plate and rubbing it well with mercury—amalgamating it, as it is termed. The superficial amalgam or alloy of zinc so formed has practically the same E.M.F. with copper as unprotected zinc, but the impurities are kept covered and separated from the solution by a metallic film of mercury, and no series of metallic contacts in a circuit from which liquids are excluded will give rise to an E.M.F. Impurities, however, that are deposited from without—as, for example, particles of reduced copper from stray copper sulphate in the solution round the zinc plate—are not so readily imbedded in the mercuric film as to pass out of free contact with the solution, and so local action from this cause takes place in spite of amalgamation.

13. It would, of course, be possible to prevent the copper sulphate solution, surrounding the copper plate, from straying into the neighbourhood of the zinc, by setting a partition or barrier of impervious substance between the plates, thus keeping them and their solutions entirely separate; but if this partition were of non-conducting material it would effectively prevent the current set up by the cell's E.M.F. from passing between the plates, and if, on the other hand, it were of conducting material, such as metal, then hydrogen would be thrown up on its surface, and polarisation would take place, so that the plan of introducing copper sulphate would be rendered useless. The difficulty is met by employing a partition of porous earthenware, a material in itself non-conducting, but containing numerous small channels, which become filled with liquid, so that, while the solutions on each side are kept apart, no great obstacle is interposed to the passage of the current. Cells which thus employ a separate solution for each plate are called double-fluid cells.

14. All such porous partitions do, however, allow the liquid solutions they separate to permeate and mingle to a greater or less extent, the process of so doing being termed *diffusion.* This diffusion takes place more slowly as the density of the separated solutions becomes more nearly equal, and as the

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porous barrier becomes thicker; but by increasing this thickness we add to the obstruction which is offered to the current in traversing the partition. This obstruction is termed *resistance*, and as electricity flows in virtue of E.M.F., so that flow is obstructed and diminished in rate in virtue of resistance. The flow of water presents an analogy, for if a current of water be flowing through a pipe from one tank to another owing to a difference of level at which the water stands in them, the rate of flow will depend, assuming that difference of level artificially maintained, upon the dimensions of the connecting pipe. By altering the length and calibre of the pipe, or by altering, as with a tap, the amount of obstruction in it, we can make the current of water as great or as small as we please; in other words, we can make the quantity of water which passes through the pipe in a given time as great or as small as we please. Just in the same way, having a certain E.M.F. in a circuit, we can, by increasing or decreasing the resistance in that circuit, make the current generated by the E M.F. as great or as small as we please; or, in other words, we can alter at will the quantity of electricity which passes through the circuit in a given time. A good conductor, offering little obstruction to the passage of an electric current, has little resistance; while a bad conductor is one that has, on the contrary, great resistance. We shall consider the nature of resistance more fully at a later period, but it will at present suffice to observe that it is measurable in terms of a definite unit, called the *ohm*, after the German scientist of that name. An ohm is roughly the resistance offered by a column of mercury one metre long and one square millimetre in section, or of 140 yards of ordinary No. 8 overhead iron telegraph wire, or of 200 yards of ordinary cable core, whose conductor weighs 120lb. per nautical mile; in other words, each of these three lengths of conductor would offer approximately the unit amount of obstruction to the flow of electricity through them.

15. We have seen that the Daniell cell, owing to the diffusion of its solution, infringes the second condition of Article 5, page 30, by the waste of material which goes on when the cell is not at work, but it has otherwise so many advantages that various forms have been adopted for different purposes and conditions of current supply.

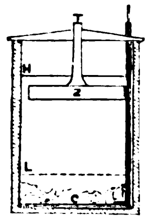

Fig. 3.

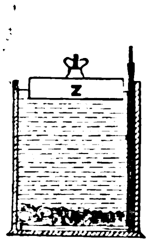

Fig. 4.

16. One of the simplest types is the gravity Daniell, shown in section in Fig. 3. In this cell the solutions are kept apart by gravitation only, the solution of copper sulphate being denser than that of zinc sulphate. A flat plate of copper, C, is therefore placed on the floor of the cell as the negative element, and covered with crystals and solution of sulphate of copper up to L, about one-fourth of the cell's height. The zinc solution of acidulated water or sulphate of zinc is then carefully added, and the zinc plate Z supported last of all a little below the surface H. Diffusion of the solutions proceeds rapidly if the cell is out of action, but sustained work tends to keep the diffusion in check owing to the more active consumption during current supply. The cell is therefore well suited for yielding continuous currents, and has always been much in favour for telegraphic purposes in the United States, where the circuits are worked on the closed-circuit principle—that is to say, with the current from the battery always flowing to line except in the spaces or pauses of manipulation, separating the signals.

17. The Minotto cell is a derivative of the gravity type, more especially adapted to transport and discontinuous work. It is represented in section in Fig. 4. The outer cell is commonly of gutta percha, which is a substance less liable to injury than glass. Above the copper plate and sulphate crystals wet sawdust is packed, and the zinc plate rests above the sawdust with the pressure of its own weight, and with its upper surface about level with the top of the cell. Whereas the gravity cell cannot be moved without disturbing the solutions and assisting their diffusion, the Minotto suffers little by transport. The sawdust takes the place, in fact, of the porous earthenware partition in the typical Daniell cell. The internal resistance is, however, greater, varying from ten to thirty ohms per cell, according to the quality and packing of the sawdust. If the cell is first set up with sawdust soaked in fresh water, the internal resistance (*see* para. 14) will be 100 ohms or more, until by working the zinc sulphate and sulphuric acid have time to form and impregnate the sawdust. The cells, if made up in this way, should therefore be left on *short circuit*, *i.e.*, with the poles (*see* para. 8) directly connected for twenty-four hours or so before they are brought into use. If required to be set up for more immediate use, the sawdust may be soaked in acidulated water. They tend to increase in internal resistance after a time, owing to the drying up of the sawdust, and fresh water has to be added when necessary, the right condition of moisture existing when the sawdust is thoroughly saturated, and a layer of liquid just rises round the base of the zinc.

18. The Thomson tray cell is another form of Daniell, of the gravitation type, specially adapted for supplying strong and continuous currents. Shallow trays, 22in. square and 2¾in. deep, form the outer cell. A square sheet of copper rests on the floor of the tray, and the sulphate of copper in crystal and solution rises above to a height of some 2in. The zinc plate, in the form of a stout grating 16in. square, shown in section at

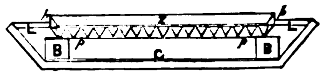

Fig. 5.

Z in Fig. 5, is supported horizontally on stoneware blocks, B B, at the corners of the tray. Stout parchment paper, *p p*, covers the lower surface and sides of the zinc grating to assist in separating the solutions, on the principle of a porous diaphragm, and the zinc solution, fresh water, or, preferably, a solution of sulphate of zinc, is poured in above until the upper surface of the grating is covered to the depth of about one quarter of an inch. The resistance of these cells is about one-tenth of an ohm each, or even less when in good working order. They require charging with sulphate of copper at regular intervals, and the density of the zinc sulphate solution should also be kept down to a density of 1·12, or about one-quarter saturation, by partly drawing off from time to time, and replacing with fresh water.

The British Iron Trade Association.—The following extract from the printed rules of the above association will prove interesting to electrical engineers at the present time:—1. The general objects of this association are—To secure a means of communication between members of the iron and steel trades of Great Britain upon all matters bearing upon the commercial interests of these industries. To attend to all matters connected with foreign tariffs, commercial treaties, and home Parliamentary business that may have a bearing upon the position of the iron and steel trades—excluding questions affecting the regulation of wages or of a purely local character—and generally to take all proper measures for advancing the interests of the British iron and steel trades in their various branches. 2. All persons, firms, and incorporated companies connected with the iron and steel industries in the British Islands, Colonies, or dependencies may become members of the association, subject to such payments and bye-laws as may from time to time be approved by the general council.

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THE TRAINING OF ELECTRICAL ENGINEERS.

There comes to us from the electrical trades in America a complaint which, if we are not greatly mistaken, will soon be echoed in this country with even greater vehemence—the complaint, namely, that the supply of trained and skilled electrical engineers does not satisfy the requirements of the profession. Our New York contemporary, *The Electrician and Electrical Engineer*, alleges that hardly any corporation or firm engaged in electric light and electric power is able to man its work adequately; and adds that it is easier to get business than to execute the work. The deficiency is apparently not so much in the quantity as in the quality of the new candidates, the demand increasing faster than the supply, "notwithstanding the influx to that [electrical engineering] vocation of large numbers of young men during the past few years, and the successful establishment of electrical courses in many of our high-class technical schools."

Speaking for this country, we cannot say with equal confidence that it is easier to get work than to execute it; but we speak well within our knowledge of facts when we state that here, as well as in the States, the demand for skilled assistance is greater than the supply. Further, we agree that the need is most felt in the higher branches of the profession, for which a scientific education, combined with technical, and especially mechanical knowledge are much to be desired, but very hard to find. In this country, however, it is not so much men competent to design a dynamo or equip a central station that are lacking, but rather men who may be trusted to carry out on their own responsibility the details of schemes entrusted to them requiring some scientific knowledge but a good deal more common sense and mechanical aptitude. Where we venture to differ from our contemporary is in the remedy it proposes, or rather counts upon, to meet

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this crying want. It is true that the money value of the required knowledge and skill is an attractive element in the problem; so attractive, indeed, that there is no lack of aspirants. What we take leave to doubt is the character of the men so attracted, and we altogether demur to the proposition that the "ample compensation" held out to them will, by increasing their numbers, add anything to the capacity and efficiency of the source on which we are at present depending for recruiting the profession of electrical engineering.

The article from which we have quoted bears out our misgivings, for in effect it says, notwithstanding the vast amount of training afforded by "high-class technical schools," the material turned out is not exactly what is wanted. We hear precisely the same objections urged in this country; and that being the case it is idle to rely on the growing attractions of the profession. "Bring in more heads to count" is a nostrum that finds little favour outside the sphere of politics, and we are quite sure that in matters of business it deserves none. What we want is not more students, but a better system of training them.

Our own belief is that the electrical engineering profession must for some time to come draw its reinforcements from older and kindred professions where practical knowledge has been acquired already, and where all that remains to be learned are the science and technics of the newer industry. As a matter of fact this is what has happened so far, the best recruits to the electric lighting business being men who have come to it as mechanical engineers and then taken the trouble to study the science of electricity. The supply from this quarter naturally does not keep pace with the demand; and there has consequently arisen a cry for the science and technical colleges to meet the deficiency, a cry which, we hasten to admit, every effort has been made on the part of their professors to satisfy by the best methods at their command. But we have said before, and we repeat it now, after inquiry among firms which have accepted young men from these colleges, that the methods are not the best calculated to provide what the workshop is in need of. Accustomed only to a long course of science classes or college lectures, the student treats the machinery merely as new appliances to experiment with, and the whole establishment as a sort of enlarged laboratory constructed for his special edification.

It is not surprising that coming to his work in this spirit the student remains a student, and the sooner he leaves as a student the better for himself. The fact may then dawn upon him and all concerned that he has begun at the wrong end. He ought to have gone to the workshop first; learnt the practical business young; and, what is of far greater value, learnt self-reliance, manliness, and how to battle with the world. Then, and not till then, he may seriously engage in scientific studies, for he will then be able to take them up wisely—that is, with a sense of the practical uses to which he can turn them to account. Instead of this, we are launching inexperienced young men upon a career for which they may be wholly unfitted, and for the pursuit of which they have missed all those years of preliminary practical training which enable men younger in years but older in experience to beat them out of the field. No wonder they fail, and no wonder their master is beginning to tell his friends that he would rather pay a good salary to a competent mechanic than take in a certificated student with a handsome premium.

For a purely scientific vocation the college training is, of course, an indispensable beginning; but what we are dealing with is a matter more nearly related to pure business than to pure science. We rather fancy that an ASSOCIATION OF ELECTRICAL ENGINEERS, which has been advocated in these columns for some time past, would have something useful to recommend in this relation. Members of such an association would know pretty well what they wanted in the shape of learners; and would not be long in agreeing as to the best mode of getting and training them. One of our contemporaries in opposing the projected association has sneered at the idea of creating a sort of diploma without which nobody could practise the profession of electrical engineer. That idea has never been entertained; but the reality is more easy of attainment than our critic seems to remember. The letters C.E. and M.S.T.E. are not diplomas; but they count for a good deal, and perhaps, notwithstanding the ballot boxes which confer the distinctions, for a good deal more outside the Institution than inside. Some care in selection is legitimately exercised in all such corporations, and the best road to the distinction will always be through a practical course of training. We very much suspect that the Technical Colleges are not supplying diplomas which the world at large will recognise, whereas an Electrical Association could and would supply them to the right sort of people; and in that case the responsibility for ignorant and incompetent pretenders would rest, not on the trade, as at present, but on the public if it chose to employ them.

THE PROPOSED ASSOCIATION OF ELECTRICAL ENGINEERS.

The step which was taken a fortnight ago has resulted in a well-nigh unanimous expression of approval of the outline scheme which has been laid before our readers. Of the total number of replies to our recent circular which have been received up to date we find that

89 per cent. express approval,
8 per cent. prefer to await further developments before offering an opinion,
and **3 per cent disapprove.**

It is necessary to remark that the issue of the circular was confined to those firms and individuals whose names appear in "The Electricians' Directory" under the head of "Electrical Engineers" (which includes a certain number of "consulting" electricians) and of "Electric Light Engineers and Contractors."

The list in the "Directory" naturally includes a tolerably large proportion of electric-bell and apparatus makers and retail dealers. And excluding those names which, although appearing in these lists, are not otherwise of any importance in this connection, we find that 80 per cent. of the electrical engineers of London and the provinces have up to this date favoured us with a reply.

A large number of suggestions, some in our opinion of great value, have been received. Of these, perhaps the most immediately important and those which we have reason to know commend themselves most strongly to the majority of leading men in London, are (1) that the Association should be one of the Electrical *and allied* Industries, with the object principally of including those mechanical engineers who design engines, &c., especially for electrical work; and (2) that the Association should be one of individual members, and *not* of firms and companies in their corporate capacity.

In confining the issue of the circular to the Electric Light and Power Engineers, it has not been our intention to influence the exclusion of Telegraph and Telephone Engineers, but we have simply wished to leave this an open question for the after consideration of those most immediately concerned. We may mention that, altogether apart from the opinions scheduled above, we have received several letters from telephone men expressing a desire to support the movement, and we may instance the case of the Managing Director of one of the

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most important provincial telephone companies, who wrote that sixty members of his staff would wish to join.

We have only to add that our own responsibility in the matter, so far as it has been of an individual character, may now be considered to have ceased. Active steps are being taken in influential quarters to further forward the movement, and it may practically be taken for granted that the announcement of a public meeting, at which all who are interested for or against the scheme will be invited to attend, will shortly follow.

AN AUTOMATIC REGULATOR FOR CONSTANT CURRENT OR CONSTANT POTENTIAL.

The regulator which we are about to describe presents nothing especially novel in principle, being, in fact, merely an automatic switch for varying resistance in the field-circuit of the dynamo (as, for instance, in the well-known Goolden and Trotter apparatus); but when we add that the design is due to MM. Jehl and Rupp, our readers will naturally expect to find both originality and ingenuity in the treatment of the details. The chief difficulty to be overcome in apparatus of this description is the avoidance of "hunting," and this it will presently be seen is effected in the apparatus in question in a very ingenious manner. In the notes before us, the designers claim that the arrangement is both simple and reliable. It must be admitted that at first sight of the adjoining figures the claim appears a somewhat doubtful one, but on a closer examination we are inclined to think that it will be admitted that the details are not nearly so formidable as they appear.

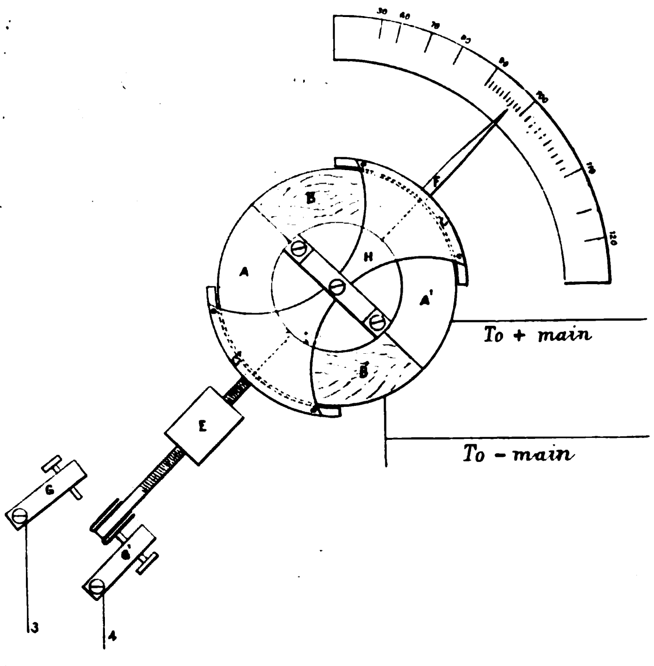

Fig. 1.

Fig. 1 shows the relay by which the movements of the switch are controlled. It is scarcely necessary to say that for constant current the coils are wound with large wire and placed in the main circuit, while for constant potential they are connected as a shunt across the terminals of the machine. The relay consists of two quadrant pieces of soft iron A A′, together with two quadrants of wood or other insulating material B B′. The disc thus formed is of some thickness, and has a groove cut around its edge, which is filled with wire. When a current passes through the coil we have, therefore, a short cylindrical magnet, the two quadrants on each face having the same polarity. A soft iron needle or armature, C C′, is pivoted at the centre, on a brass bridge, H, and is shaped also in quadrant form. The whole arrangement resembles in outline a quadrant electromotor. A pointer, F, extends from one of the armature quadrants, while the other carries a projecting rod, upon which is screwed a counterpoise, E; this can be adjusted to any desired position. At the lower end of the rod are two platinum contact springs, D, shown by the heavy lines in the figure. The rod is also connected with one of the terminals of the coil of the relay, and forms part of a circuit, which is a shunt upon that coil. The instrument is fixed upon a vertical support, and tilted as shown; the weight is then adjusted until the distance traversed by the pointer between the limits of the permissible variation of the E.M.F. (or current) tends to be as great as possible, so as to enable the springs D to make firm contact. The scale of deflection is usually very irregular, as seen in the figure. At G and G′ are contact pieces, with one or other of which the platinum springs make contact when the limit of variation is exceeded in either direction.

These contact pieces are connected by the wires with the studs E and E′ (Fig. 2). Attached to these are spiral springs, and

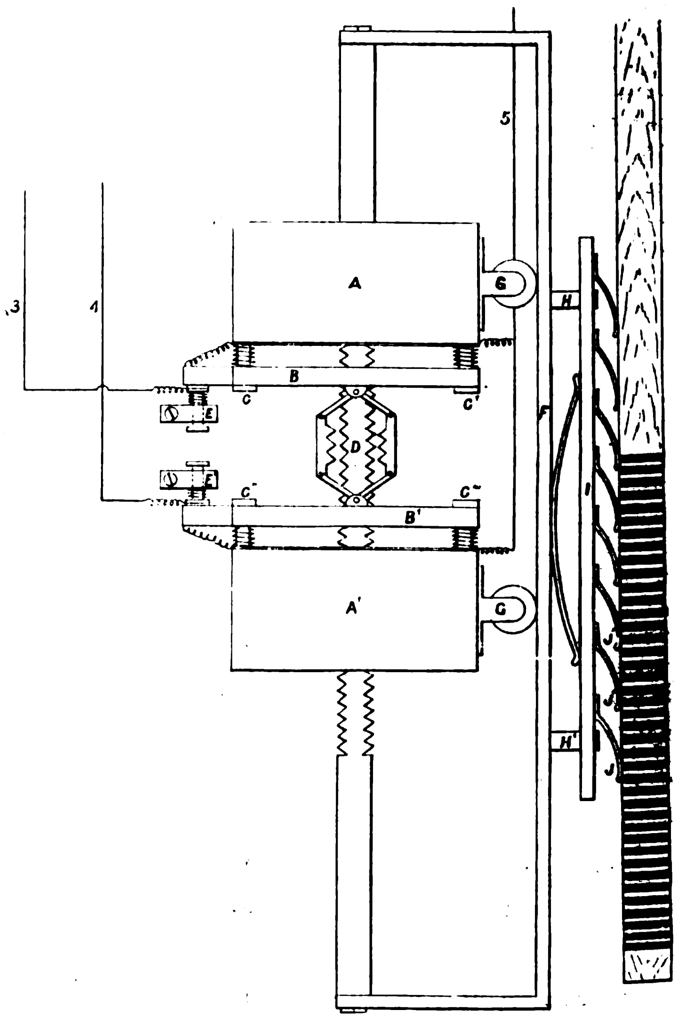

Fig. 2.

against these springs rest the armatures B B′. On its way to the coils of the electro-magnets A A′ the current passes through the studs and springs and across the armature itself. If, then, the armature is attracted its first movement towards the magnet is followed by the spiral spring, but when this has completed its extension contact is broken, and the magnet loses its power. The action is precisely that of an ordinary electric bell make-and-break.

The magnets A A′ (Fig. 2), which actuate the switch and place resistance in or out of the field circuit, are of somewhat peculiar construction. They consist of a circular disc or cylinder of soft iron, in which a groove is turned on the flat side, and which is also bored out in the middle. A diametral cross

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section is shown in Fig. 3. The coils are wound on a former and dropped into the groove B B′ (Fig. 3). We thus obtain a compact ironclad magnet, having one polarity at the centre and the other around the circumference, both poles being annular in form. A circular disc of brass, having a central aperture, is laid over the face, and not only serves to hold the coil in place but also prevents the sticking of the armature. Two of these magnets are placed face to face some little distance apart, and each is provided with a similar armature. The latter is also annular in form, and is held in position by pins c c′ c″ c‴, which pass through small holes in the margin of the flat ring. Upon these pins are mounted spiral springs which resist the approach of the armature to the poles.

A brass rod, D, passes through the central aperture in both magnet cores, and is provided with ratchet teeth along the middle of its length. To each armature is attached, as shown, a sort of jointed parallelogram gripper, having three teeth on either side.

The action will now be easily understood. If the relay closes the circuit of the magnet A, the armature B is attracted and moves upwards; the gripper closes with the rod D and shifts the contact frame (F, H, and I) in the same direction. But the next moment the circuit is broken at E, the armature falls back, opening the gripper, and allowing the contact frame to remain at rest. The circuit is again closed at E, and the frame is shifted further forward until the potential has been adjusted so as to allow the relay to finally open the circuit. The repeated small adjustments are, of course, effected with great rapidity; but an adjustment of this intermittent nature is undeniably the most effectual cure for "hunting."

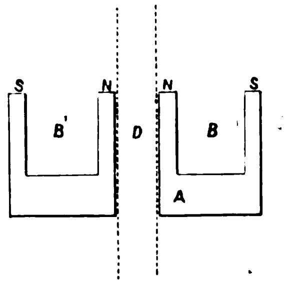

FIG. 3.

It is scarcely necessary to describe the remaining features; 5 is the wire completing the shunt circuit of the magnets and the relay rod. G G are rollers on which the moving frame slides; at F a bow spring presses outwards the part I, which carries the contact spring J J′ J″. Resistance is cut out by short-circuiting, so that there is no sparking at these points.

EXPERIMENTS ON THE POSSIBLE ELECTROLYTIC DECOMPOSITION OF CERTAIN ALLOYS.*

BY PROF. W. C. ROBERTS-AUSTEN, F.R.S.

The original suggestions framed for the guidance of the committee provided for an examination of the question whether molten alloys would conduct electrolytically, and during the year 1886 various experiments were made in the Mint laboratory, the results of which were in all cases negative, but were useful as indicating the method of working which appeared to afford the best prospect of success. The selection of a suitable alloy is by no means easy. It seemed well to begin by employing lead-gold and lead-silver alloys for the following reasons:—Matthiessen† has shown that these alloys, when considered from the point of view of their electrical resistance, belong to a class described by him as "solidified solutions of one metal in the allotropic modification of another."

Some work has already been done on the alloys considered as solutions of the precious metals in lead. I have already submitted to the British Association preliminary results on the diffusion of silver and of gold in molten lead,* and some unpublished experiments of my own have shown that certain silver-lead alloys when poured in spherical moulds, capable of holding about 2·6 kilogrammes of lead, set as a whole without exhibiting any tendency to the re-arrangement of the constituent metals known as "liquation"—that is, the constituent metals do not readily fall out of solution. Such alloys are those which contain less than 3 per cent. of silver. The alloy containing 51·06 per cent. of silver, to which the formula Ag_2Pb may be assigned, also sets as a whole without rearrangement of its constituents. Guthrie, in an admirable research, interrupted by his lamented death, has shown† that a "Eutectic" alloy of silver and lead probably contains less than 1 5 per cent. of silver—that is, it is the alloy of the lead-silver series which has "a minimum temperature of liquefaction, . . . a temperature lower than that given by any other proportion," and he points out that such eutectic alloys are "neither atomic nor molecular" in constitution.

The curves representing the electrical resistance of *solid* lead-silver and lead-gold alloys are continuous, and do not reveal the existence of any special alloy differing widely in resistance and in physical properties from the rest of the series. In the case of the copper-tin series of alloys, investigated by Matthiessen‡ in 1860, by myself§ in 1879, and by Dr. Lodge‖ in the same year, the alloys $SnCu_3$ and $SnCu_4$ stand quite apart from the rest of the copper-tin series both in colour, lustre, and electrical resistance.

It will be specially important to ascertain whether the passage of a strong current will enable the constituents of the copper-tin series of alloys to be separated, but unfortunately the alloys of these metals have high melting-points, and as the alloys have to be kept molten by the external application of heat during the passage of the current, the difficulties of manipulation are greatly increased. I considered, therefore, that it would be better to begin with the lead-silver and lead-gold series, which have comparatively low melting-points, and of which, as I have already stated, much is known concerning their behaviour as solutions. One additional advantage in the employment of these alloys is presented by the readiness with which variations in their composition may be determined. This is a point of some importance, for if, as Dr. Gladstone has already suggested, the results of passing the current through the molten alloys were only very slight changes in composition, the errors of analysis might overshadow the change. In the case, however, of the lead-gold and the lead-silver alloys, the method of assay by cupellation enables very minute changes in composition to be detected, and the amount of change can be determined with great readiness and accuracy.

The preliminary experiments need not be described at length; it is only necessary to state that fire-brick U tubes, about five millimetres in section, were employed, and that in them the fluid alloy was kept molten by the external application of heat. The electrodes first used were stout iron-wire terminals of a forty-pint cell Grove battery; the passage of the current was maintained for thirty minutes, and portions of metal were tilted out from either end of the tube. These samples were then assayed, and it was found that no variation whatever had been produced by the current. The passage of the current was not maintained during the time the samples were taken, and, as diffusion would probably rapidly restore the uniformity of the alloy, if the current did produce any change, care was taken in subsequent experiments to remedy this defect in the manipulation.

Dr. Lodge, in a letter to me dated April 5, 1886, asked whether it was possible to employ tubes one millimetre in section. I therefore broke off the bowls of two tobacco pipes, leaving about ten millimetres of stem attached to each of the bowls, which were then filled with the lead-silver alloy (con-

* Read at the British Association, Manchester, as part of the Report of the Electrolysis Committee.
† *Phil. Trans.*, 1860, p. 161.

* Report for 1884, p. 675.
† "On Eutexia," *Phil. Mag.*, 1884, Vol. I., p. 462.
‡ *Phil. Trans.*, 1860, p. 85.
§ *Phil. Mag.*, 1879, Vol. II., p. 57. ‖ *Ibid.*, 1879, Vol. II., p. 554.

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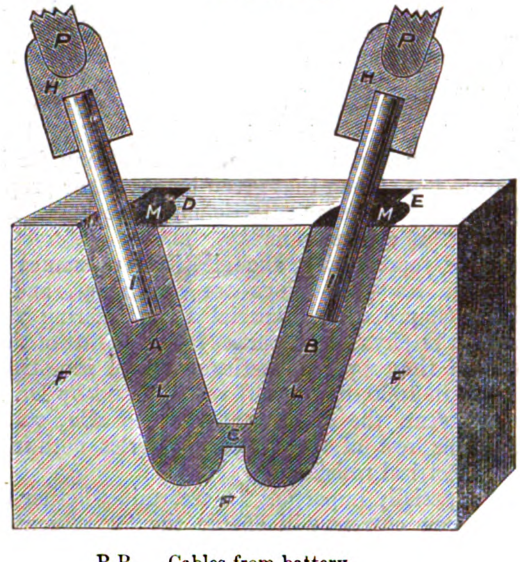
taining 2 per cent. of silver) by placing them in a bath of the fused alloy and allowing the metal to enter the bowls through the stems. A current from the forty-cell battery was then passed for twenty minutes, when both bowls were rapidly withdrawn. The contents proved on assay to be identical in composition. The ends of the stems while in the bath were about five millimetres apart.

The nature of the subsequent experiments is best shown by the sections of the firebrick receptacles submitted to the committee and by the following diagram :—

Scale one half.



P P, Cables from battery.
H H, Copper holders.
M M, Cavity for withdrawal of sample.
I I, Wrought-iron rods.
F F F, Soft fire brick.
L L, Silver-lead or gold-lead alloy.

The secondary batteries used for the electric lighting of the Mint were placed at my disposal by Mr. R. A. Hill, the superintendent of the Operative Department, to whose assistance I am much indebted. The weight of the alloy used in the experiments was about 500 grammes.

TABLE A.

Samples.	Time from starting current.	Weight in grammes of Gold obtained from two grammes of the Alloy. Positive Side.	Negative Side.
1	0′	(1) 0·04022 (2) 0·04007	(1) 0·03905 (2) 0 03855
2	10′	(1) 0·04029 highest (2) 0·04026	(1) 0·03954 (2) 0·03920 lowest
3	23′	(1) 0·03988 (2) 0·03973	(1) 0 03944 (2) 0·04010
4	40′	(1) 0·03980 (2) 0·03966	(1) 0·04009 (2) 0·04010
	Totals	0·23962	0·23847*
5	45′	(1) 0·03917 (2) 0·04016	(1) 0·03926 (2) 0·04051

* Total difference + 0·00115 grm.

With the appliance arranged, as shown in the diagram, the momentary application of twelve cells (supplied by the Electrical Storage Company) projected the metal (a 5 per cent. lead-silver alloy) from the firebrick receptacle, while ten cells rapidly heated the iron terminals to redness and fused the lead "lugs" of the cells. It was not found practicable to employ more than four cells for any experiment which lasted more than a few minutes, and in no case did the strength of the current exceed 300 amperes.

The following experiment with a gold-lead alloy containing about 2 per cent. of gold is given as showing the method of working :—Before melting the alloy two grammes yielded on assay 0·03981 gramme (or 1·99 per cent.) of gold ; after the fusion had taken place the samples taken gave on assay the results shown in Table A. They were withdrawn from the cavities marked M, M, on the diagram at the periods indicated in the table. The current used was from three of the secondary cells connected in series.

For the purpose of controlling the results, samples 1 and 5 were taken from the molten metal while no current was passing, and were assayed with the rest. It will be seen from the above table that the difference varied from a minimum of one ten-thousandth as deduced from the total difference found on assaying samples 2 to 4, to a maximum of five ten-thousandth presented by sample 2. The alloys of lead with 2 per cent. of silver and with 51 per cent. of silver also gave negative results, and experiments as a whole, so far as they have yet been carried, tend to show that an alloy conducts metallically, and that its constituents cannot be separated by an intense electric current. The experiments, however, can only be considered to be preliminary. They must be repeated and extended, and alloys of which arsenic is a constituent must be tried ; and further, it is specially important to examine the behaviour of such alloys as those of tin-copper and bismuth-gold, as certain members of both series show marked points on the curves representing the electrical resistance which would appear to indicate the existence of definite compounds.

DISCUSSION.

Dr. GLADSTONE said that the suggestion that this experiment could be made better by means of a change of resistance attributed to him by Prof. Austen really emanated from Mr. Hibbert, the speaker's assistant. Mr. Hibbert had recently been making experiments by employing fusible metal which melted under 100 degrees of temperature, with a result similar to that brought under the notice of the section by Prof. Austen—that was to say absolutely *nil.* There seemed to be no transference whatever of the metal from one point to the other. He and Mr. Hibbert agreed that the investigations had been carried far enough to warrant them in saying that the result was a negative one.

Prof. S. P. THOMPSON : I wish to ask Prof. Wiedemann whether the alloys used in his experiments belonged to that class of alloys the formation of which is accompanied by an evolution of heat or not.

Prof. WIEDEMANN : I think not.

Sir WM. THOMSON : I think that the paper of Prof. Austen speaks for itself. The expressions of opinion that Dr. Gladstone and Prof. Wiedemann have given confirm the result, and I think that this discovery has been quite settled and made known to the world to-day for the first time. It is a most valuable and important contribution to our knowledge on the subject.

BERNARDO'S METHOD OF ELECTRIC WELDING.*

BY DR. R. RÜHLMANN.

When the author first saw Dr. Bernardo's method in use at St. Petersburg he was involuntarily reminded of Columbus and the egg. It has been well known for many years that almost all substances were readily fusible in the electric arc, and Siemens, Wallner, Cowles, and others have done much work in the direction of electrical welding by this means, with more or less success. The principal point in which Bernardo differs from his predecessors is that he makes the metal to be welded *itself the negative pole*, the positive being a carbon rod. The strong reducing action thus brought to bear on the metal keeps it perfectly clean and unoxidised. If the poles are reversed the fluid metal is promptly covered with a layer of oxide, which makes the welding almost impossible, and there is also great danger of burning holes. Bernardo uses as a source of current seven sets of accumulators in parallel, each set 70 cells in series. These he charges continually while

* *Elektrotechnische Zeitschrift*, November, 1887.

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working by a shunt dynamo giving 120 amperes at 175 volts. He uses special battery plates made of lead strip, as he has found that "pasted" cells will not stand the very heavy charge and discharge currents he employs. Messrs. Rothschild had great trouble at Creil from using "pasted" plates.

The E.M.F. and current required depend on the size, &c., of the work to be done. As an example, to weld together two pieces of ⅜in. boiler plate, 40 cells in series and three in parallel would be taken, one end joined to the plates, and the other by a flexible lead to a 1in. carbon rod in a portable holder. The metal is then touched with the rod, which is immediately withdrawn from a quarter to half an inch, thus striking an arc. The metal at the point where the arc forms melts immediately, like so much wax, and runs perfectly fluid. Through the dark spectacles the arc appears like a blow-pipe flame, and is manipulated much as if it were one. If the effect is too strong, and the metal boils and evaporates, fewer cells in parallel are used; if the arc goes out too often more are added in series.

If heavy pieces of metal of high melting point are to be joined, large currents and E.M.F. must be used, the carbons being proportionately larger, and *vice versâ*. The action of the arc is, like that of a blow-pipe flame, very local; only that part of the metal which requires to be melted is much heated, and the moment the arc is removed the fluid metal solidifies.

The most refractory metals are instantly liquefied, and the work can be done with great rapidity.

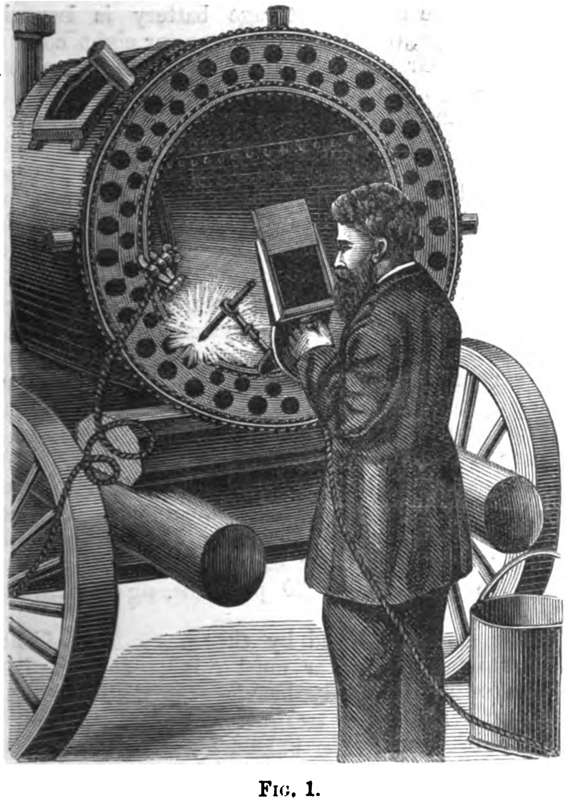

Fig. 1.

The metals to be operated on require hardly any previous preparation, as with the high E.M.F. and currents used even a heavy coating of rust is at once fused. A little sand is used to unite with any oxide not reduced, and the slag thus formed protects the finished part from the oxygen of the air while cooling.

It is a great advantage in Bernardo's method over ordinary welding that the heat can be so easily taken to the place required, instead of having to bring the metal to the forge. Fig. 1 is from a photograph taken when repairing a boiler, and is a good example of the extreme simplicity and convenience of the method. The negative lead is attached to any part of the boiler by the small vice on the left, and then by taking the positive carbon-holder in the hand any part of the boiler can be operated on.

Besides welding two pieces of steel, wrought or cast iron, &c., together, the process has been used to join iron with copper, tin, zinc, brass, lead, steel, or cast iron with perfect success, as also to weld copper and brass, brass and brass, &c., and to *coat* iron with copper, tin, and lead. It may also be used to cut up as well as join a piece of iron plate, &c., as the melted metal runs off like water if no means are taken to retain it; and it may be noted that the process may even be used *under water* both for welding and for cutting metals.

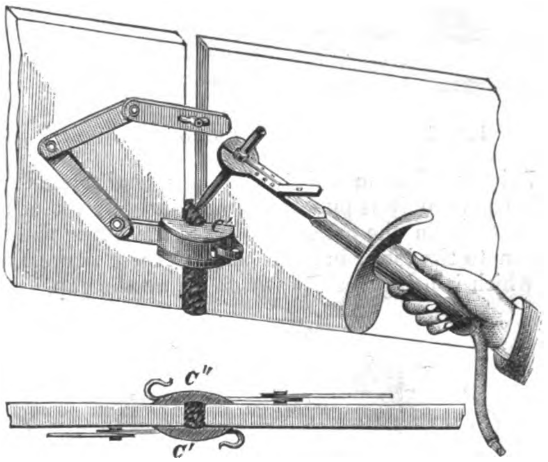

Fig. 2.

Since the action is so rapid, and the metal so quickly cooled after welding by conduction to the surrounding parts, there is no time for any appreciable chemical action to take place, as the following analysis shows:—

—	Steel.		Iron.	
	Unworked.	Melted.	Unworked.	Melted.
Iron	98·86	99·39	98·90	99·43
Carbon	·48	·25	·34	·14
Silicium	·04	Traces	Traces	Traces
Manganese	·5	·25	·50	·23
Sulphur	·04	·04	·14	·09
Phosphorus	·08	·07	·12	·11
	100·00	100·00	100·00	100·00

The "melted" columns are analyses of pieces obtained by allowing the fluid metal to run off under the arc instead of retaining it in place. A further advantage of joining metals electrically is that nothing of the nature of a solder with different chemical and physical properties to the metals treated is employed, and that the joint is extremely little if at all weaker than the original unworked metal.

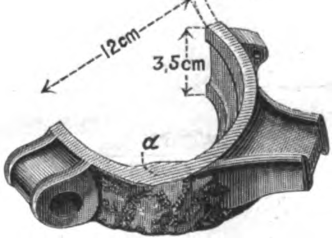

Fig. 3.

Fig. 2 shows the method used for joining two upright plates. C′ C″ are carbon blocks to keep the fluid metal in, and are shifted up from time to time as the joint is made.

Fig. 3 is a cast iron excentric strap, which was broken with a hammer at *a*, and then mended by fusing it together with

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small pieces of rolled iron, a little sand being used as flux. The joint is perfect, and neither hard nor brittle.

Figs. 4 and 5 show butt and lap joints, and Fig. 6 a pair of plates in process of being electrically riveted.

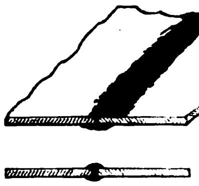

Fig. 4.

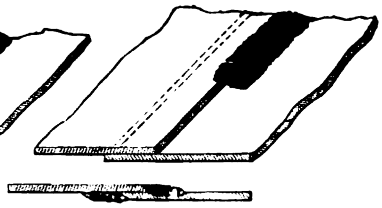

Fig. 5.

Fig. 7 shows what may be called a "semi-riveted" joint. The upper plate only is punched, and a sort of rivet of molten metal built up in the hole, the edge of the upper plate being welded on to the lower in addition (*f* in these figures) a piece of iron which is being fused down to fill up the gap.

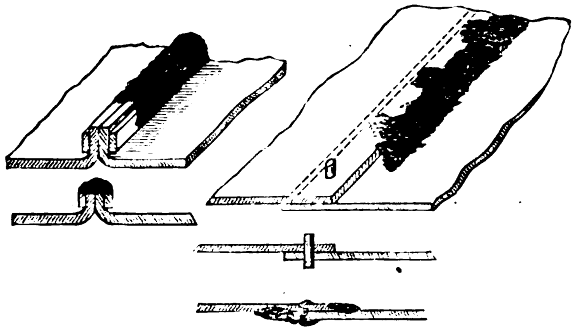

Fig. 6.

Fig. 8 shows two pieces of a thick iron rod being joined, a carbon block *b* being used to retain the molten metal.

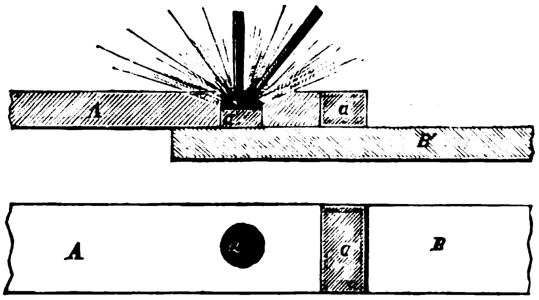

Fig. 7.

Among other uses may be mentioned that of welding fine steel on to a cast iron body for tools, &c., without any risk of

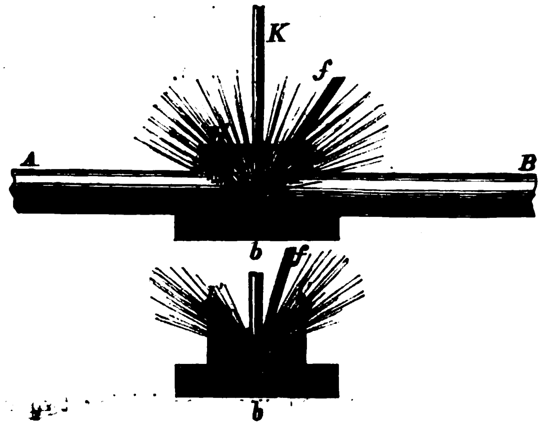

Fig. 8.

the steel being burnt, and for filling up blow holes which may only have been discovered after a considerable amount of work has been done on a piece of metal.

THE ARGUMENT AGAINST STORAGE BATTERIES FOR ELECTRIC TRACTION.*

The Bentley-Knight Electric Railway Company begs to submit its criticism upon the use of the storage battery for street railway purposes.

No idea could be more attractive than that of a self-propelled car, carrying within itself its own energy—independent of any connection with line wires—and dispensing with expensive conduits and unsightly elevated conductors. On the advent of an apparently practicable storage battery, in 1881, all these advantages were claimed for it. It shortly demonstrated its utter worthlessness as an adjunct to commercial electric lighting, but its promoters claimed that it possessed a peculiar fitness for tramway use. It has been paraded through every city of Europe, and has, to judge from Press comments and *ex parte* statements, never failed to make most successful and startling exhibitions. The boom has now reached this country, and New York, Philadelphia, and Boston have each been favoured by the attention of the several inventors and their exploiting companies. Since the European experiments of 1882 little or no material progress has been made in the practical use of the storage battery for street car purposes, and it is our belief, based on most careful investigation, that its radical structural difficulties cannot be overcome. It would be profitless to discuss them here; nor will we dispute the allegations as to weight, efficiency, &c., which the enthusiastic promoters make.

We will assume that the storage battery is beyond the experimental stage, capable of driving a car eight hours without recharging. Granting the most favourable premises, we will make a short practical comparison between the storage and direct systems, both as to operating expenses and first cost. We will also assume that a set of street car batteries will weigh 3,200lb., that they will give a return of 65 per cent. of the electrical energy expended in charging, that a set which will run eight hours can be charged in ten hours, and that a set will run 12,500 miles without renewal of the batteries or extensive repairs.

1st. Cost of Operation.—Two great losses are chargeable against the economy of the storage system, viz.:—Loss in conversion of energy in the battery and the additional weight carried on the car. In the direct system, electricity from the generating dynamo is transmitted to the motor on the car by the line conductors. In the storage system, electricity from the dynamo is used to charge the batteries, which, in turn, supply the motor. In the latter system the loss is conceded to be 35 per cent. In the former system, it is a matter of simple arithmetical calculation to make the loss inappreciable. It should never exceed 5 per cent., however long the line. This leaves a difference of 30 per cent. against the storage system.

A greater loss is entailed by the heavy load of batteries which the storage system car must carry. It necessitates a heavier car construction and a heavier motor, all of which adds to the weight. In practice two motors are often used. The additional weight entailed by the storage system easily reaches 4,000lb. per car. The motor and driving mechanism for a car run under the direct system weighs 1,600lb. The equipment where batteries are used is necessarily heavier on account of the added battery weight to be moved, but we will keep the same figure for both. A car weighs nearly 5,000lb. In Boston (1886), the average number of passengers per car mile was 10, so that the average load may be put at 1,400lb. We then have the following summary:—

	Storage system.	Direct system.
Car	5,000lb.	5,000lb.
Motor, &c.	1,600lb.	1,600lb.
Passengers	1,400lb.	1,400lb.
Batteries, &c.	4,000lb.	——
	12,000lb.	8,000lb.

* *An ex parte statement read before the American Street Railway Convention at Philadelphia by the representative of the Bentley-Knight Electric Railway (Conduit System).*

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That is, 50 per cent. more power must be expended to propel the storage car, and 30 per cent more power to overcome the loss of conversion in the batteries, making a total of 80 per cent. greater cost for power than the direct system. This means not only 80 per cent. more coal consumed but 80 per cent. added to the size and cost of the steam and dynamo plant in the generating station.

There are additional losses in the storage system which are less easy to compute, but which are hardly less serious than those mentioned. Twelve thousand five hundred miles are given as the life of a battery. Now, 100 miles per day is not an excessive mileage for an electric car, so that the battery must be renewed, wholly or in part, every 125 days, or three times per year. What this would cost it is impossible to say, but it is plainly a serious item. On the other hand, the depreciation of an overhead wire, or a conduit, is very slight, not more than 3 or 4 per cent. per annum. The handling of storage batteries is also a very considerable item. To transfer 3,200lb. into and out of a car two or three times a day is not a slight matter, while the shifting and removal necessary to a large plant must be added to it. None but skilled labour could be employed in handling, recharging, and taking care of the batteries. That has been conclusively proved.

2nd. First Cost of the Storage System.—There is little reliable data on this point, but putting a very moderate estimate upon it, it far exceeds that of the most expensive direct system. There should be at least three sets of batteries for each car—a considerable increase in the motor capacity—80 per cent. more dynamo and steam plant in the generating station, and twice the floor space, since each car must have a stand for charged and discharged batteries. This could not cost less than $2,500 per car, which is to be balanced against the conduit and line conductors of the direct system. The cost of the latter varies, of course, with the number of cars per mile. Taking a well-known road in Boston, however, which has 700 cars and 70 miles of track, there are 10 cars per mile, which, equipped with conduit and conductors at $4 per foot, would cost $2,000 per car. As a matter of fact, one-fourth of this mileage could be equipped with overhead wire at $2,500 per mile, which would bring the cost to $1,650 per car.

An important fact, which we have left out of this computation, is that most existing roads must be equipped with new and heavier track to fit them for the weight of storage cars. The present rails will stand an addition of 1,600lb. to each car, but not an addition of 5,600lb. (The most widely advertised storage car run in this country weighs over 6½ tons.) These facts are plain and simple, and in view of them it is difficult to see how the introduction of the storage system can be seriously contemplated when conduit and elevated conductor roads on the direct system are feasible. As we have said before, the superficial appearance of the storage battery for street cars is very attractive. It is a simple electrical problem to charge a battery and run a car for an occasional trip. A boat equipped with a battery has crossed the English Channel, while for lighting railway trains, where weight and expense are no object, and the work easy and constant, it has a certain value; but for practical street car work it has just enough promise to make it a dangerous and insidious deceit. The storage power, however, is a disease which users of electricity must go through as a child has the measles. The electric lighting interests went through it some years ago at an enormous expense, and to-day not one of the large electric lighting companies is supporting the storage battery. If this paper, hurriedly written and far from complete, will in any degree mitigate the malady to the street railway interests, it will have attained its end.

A German Central Lighting Station Tariff.—The central station at Mailand is now supplying current by meter on the following sliding scale:—Up to 40 hours 12 centimes per ampere (say 1·2d.), 6 centimes per 10 candle-power lamp, 9 centimes per 16 candle-power lamp, falling to 11, 10, 9, 8, and 7·5 centimes per ampere, according as the consumption increases to 80, 100, 125, or 150 or more hours, with proportionate charges for 10 and 16 candle-power lamps. The rent of meters is: 50-lamp, 5s.; 50 to 100, 7s. 6d.; over 100, 10s.

REVIEWS.

Recent Advances in Electricity, Electric Lighting, Magnetism, Telegraphy, Telephony, &c., &c. Edited by Henry Greer, New York College of Electrical Engineering.

Amongst the phraseology of polite literature we are unable to find any available form of expression which contains the full and precise analogue of the colloquial term "cool cheek." We wish there were some such phrase. In default, we are driven at times to the use of some provokingly mild and common-place expression—such, for instance, as "singular." In what follows, however, if we should make use of this milder form, our readers may, if they please, read into it the meaning hinted at above. They will presently agree with us that never was a more vigorous expression more loudly called for.

This book contains an abstract of Edison's recent paper on the pyro-magnetic dynamo, a reprint of an article on "Phelp's Induction Telegraph," a feeble chapter on navigating balloons by electricity, and a large number of extracts from newspaper articles, antiquated patent specifications, prospectuses of joint-stock companies and out-of-date scientific papers, all of which are concerned with various kinds of storage batteries. Considering that this last subject occupies three-fourths of the book, *while the information is in no case brought down to a later date than the summer of 1883*, we venture to think it decidedly *singular* that the work should be entitled "Recent Advances in Electricity." But the lower part of the title page is even more singular than the top. We are informed thereon that the work includes "articles by Editor of *Electrician* of London (*sic*), Prof. Thomson of London, and Prof. Edison." The words "of London" had been scratched out with a knife on the outer cover of the copy which reached our hands, but there happened to be an inner title page which had not received the same careful attention. Under almost any other circumstances we need scarcely say that we should feel gratified at thus being connected with "Prof. Edison" and "Prof. Thomson of London" (although we hear for the first time of the latter gentleman); but we are free to confess that when this honour involves also that of being "edited" by Mr. Greer, we do not take it as a compliment. Our four-year-old article on "Storage Batteries" was doubtless highly useful and instructive when it first appeared, but we regretfully admit that we are not entitled to claim for it a permanent place in the literature of science, certainly not under the title which Mr. Greer has chosen to give it. As for Prof. Thomson, he has been even more cruelly treated. Mr. Greer has evidently attempted to "abstract" him (in more senses than one). The following is a specimen of the result:—"As this was one point of Dr. G.'s *(sic.)* explanation, both he and Mr. Tribe, who has always shared Dr. G.'s researches in this field, and Prof. Lodge repeated their experiments, and *Nature* had communications from the two gentlemen, which (*sic*) both adhered to their former opinions."

Perhaps the most singular fact of all is that this volume is priced at four shillings.

THE PROGRESS OF THE THOMSON-HOUSTON SYSTEM.

The story of the "rise and progress" of the Thomson-Houston system of electric lighting is beyond question one of the most remarkable in the annals of applied science. It is difficult to realise that it is now little more than four years ago that this system was first heard of, and some time elapsed, even in America, before it began to attract any great attention. In this country the interest first aroused was due to the difficulty of grasping the exact method of working of the machine, and to this day great is the tribulation of students who strive to master its cycle of operations. Notwithstanding these features the system came rapidly to the front, and we learn that at the present moment the parent company in America are behindhand in the execution of orders to the extent of some 4,500 arc lamps and apparatus, 15,000 incandescent lamps and fittings, and a corresponding number of dynamo machines. By the end of this year it is expected that the total number of these arc lamps installed in America will reach the enormous total of 50,000; while the

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number of central stations working this system will at least reach 300, if it does not exceed that figure. The incandescent lamp has been by no means neglected by this company, and in our issue of March 18th, 1887, we illustrated and described the arrangement by which lamps of low resistance are run in simple series upon the arc lamp circuits. These lamps are made in various sizes, giving from 16 candle-power to 125 candle-power. In addition to this method, "distributors" are employed, which enable any type of lamp to be run in multiple series on constant current circuits. That these systems are thoroughly practical may be judged from the fact that already some thousands of incandescents are at work on these conditions.

The distribution of power by means of motors adapted to work in series with constant current is also rapidly becoming an important feature of the central station business. The value of an addition which enables the plant to earn revenue by day as well as night cannot easily be over-estimated. The average earnings of the American local companies have enabled dividends of from 8 per cent. to 16 per cent. to be paid upon arc lamps alone, so that with the further sources of revenue which have been named, their financial prospects may be held to be of a solid character.

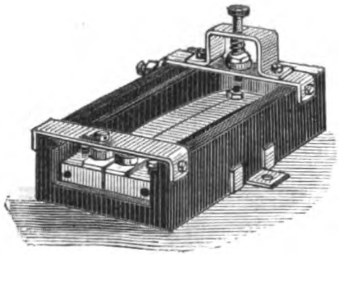
The most important event in the recent history of the company has been the signing of a working agreement with the Westinghouse Company, whereby the former becomes entitled to employ the alternating system for long-distance distribution, while the latter will make exclusive use of the Thomson-Houston arc lamp. In the hands of Prof. Elihu Thomson the transformer system may well be expected to undergo new development.

At present the business which is chiefly engaging the attention of the experimental staff of the company is the production of an arc lamp of lower candle-power than the 1,200 candle-power and 1,000 candle-power lamps which have hitherto been made. A lamp of 800 candle-power will shortly be ready for issue, though we may anticipate that the movement in this direction will not stop at that point.

In conclusion, we may remark that it is impossible to avoid the recognition of the remarkable nature of the success that has followed this company's operations, and though we could wish that they and the scene of their labours had been on this side of the Atlantic, we none the less warmly congratulate the representatives of the Thomson-Houston Company on the unqualified success of the system.

"EXCESS" ALARMS FOR SECONDARY BATTERIES.

We illustrate herewith a simple form of alarm which is intended to be used with secondary batteries when either the charging or discharging current exceeds the proper limit. This alarm has been designed by Messrs. Drake and Gorham, in conjunction with the United Electrical Engineering Company, and is manufactured by the latter. The apparatus is so arranged that whenever the current exceeds the proper limit an electric bell comes into circuit and continues ringing until the normal conditions of working are restored.



The principle adopted is that of the thermic alarms, which depend for their action upon the bending of a compound metallic plate under variations of temperature. In this case a strip or plate, consisting of two metals rolled or soldered together, has a narrow slit cut in it almost, but not quite, from end to end, thus forming a narrow flat U-piece, the ends of which are rigidly held and connected to terminals, which are placed in the main circuit. The closed end of the loop is free to move, and carries a carbon stud. Immediately opposed to this is a similar stud, to be connected through an ordinary electric bell to one of the cells in such a manner that when the two studs make contact the current from one cell only will pass through the coil of the bell. The distance between the two contacts is adjustable.

The tendency of the current in passing round the loop is to cause the free parts carrying the contact stud to bend upward, and should the pre-arranged limit be exceeded alarm is immediately given by the bell, which may be fixed at a distance if required. The alarm is found to be practically constant and reliable, variations in the temperature of the atmosphere being inappreciable in effect.

The usefulness of these thermic alarms is not, of course, confined to accumulator work, as they may be employed in connection with any arrangement of circuits the current in which needs to be controlled.

Cut-outs and other forms of control have been designed on the same principle (which certainly lends itself to economy in manufacture), and will, we understand, be shortly introduced.

CORRESPONDENCE.

DEEP-SEA CABLE SOUNDINGS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I cannot quite agree with you in your criticism on Mr. Stallibrass's very able paper on "Deep-Sea Soundings," where you say in your last week's "Notes," that he "rather overdid his advocacy of preliminary surveys for cable operations," and inasmuch as in the same column you refer to my remarks in the discussion on the subject, I think it as well to express my dissent. On the contrary, I most cordially agree with Mr. Stallibrass in the matter. All that I have ventured to submit was that he would, perhaps, have actually strengthened his point if he had mentioned the arguments (however little weight they may carry) on the other side of the question (if only on principle), and to some extent balanced the one against the other. This, in my opinion, Mr. Stallibrass could well have afforded to do.

I then alluded to the arguments adverse to such preliminary soundings, at the same time expressing an opinion that under certain circumstances they were very possibly impracticable owing to lack of time, or, indeed (in the earlier days), through scarcity of money; and that, therefore, it would be, perhaps, inexpedient to blame instances where similar preliminary surveys had not been effected. We should, I think, remember that it is only by these somewhat dearly bought practical experiences that we have learnt the absolute necessity of such surveys, and discovered that soundings at distances of 30 miles apart are no guide as to the configuration of the bottom, and, moreover, afford only a rough estimate of slack cable requirements.

Again, often through no fault of theirs, contractors are frequently compelled to lay a cable by a certain date, those by whom it is ordered being constantly, even nowadays, ignorant of the value of preliminary surveys.

It seems to me that a big allowance should also be made to early submarine telegraphy for the very altered circumstances brought about by the practical introduction of pianoforte steel sounding wire as being especially adapted to our work. My remarks were merely intended as a humble, and possibly useful, addition to Mr. Stallibrass's very able paper, from a business point of view.—Yours, &c.,

CHARLES BRIGHT, JUN.

THE TEACHING OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your review of Mr. Larden's new text-book touches on the best order of treatment of electrical and magnetic subjects. That this should be very connected and lead the student step by step there cannot be two opinions. My own view is that this end is not secured when the text-book is an historical compendium, subjects being treated in their historical order, or when large demands are made on a student's imagination in pursuing some physical theory. Experience in dealing with students has led me to the firm conviction that the study of the simple electrical circuit, electrical units of measurement and measuring instruments are the most easily comprehended to start with. By measurement abstract ideas are reduced to the practical.

The recent works by Prof. Ayrton and Profs. Stewart and Gee are distinct innovations on the old historical and general style, and their practical value to the student is widely felt.

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The subject of electrostatics is a growingly important one in connection with alternating currents, but owing to the fact that measurements are less easily made than in electro-dynamics and magnetism, it seems more desirable that the *entrée* to the study should be through the latter subjects.—Yours, &c.,

H. D. WILKINSON.

School Electrical Engineering, 12, Princes-street, Hanover-square, W.

PRIMARY BATTERIES: A CHALLENGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I be allowed to trespass on your valuable space in reference to those bugbears, primary batteries, as one most interested in the Holmes-Burke type?

There are several installations of modified type of above (the improvements of your humble servant), and the latest construction under my patent will, I trust, be of service, both for lighting, telegraphic, and mining purposes. It is not my intention to raise a company, or ask any one for a penny. The chief cost of working these primary batteries is not the labour, but consumption of materials.

I challenge any primary battery inventor or maker to the following trial, but the plates used must not be prepared electrolytically—as I look upon such as accumulators or secondary batteries—and the cells must be of similar size and number to mine. The battery shall be prepared and allowed to run a given number of Swan-Edison lamps of a given E.M.F. and candle-power. The runs shall extend over fourteen days or more; the time occupied in labour shall be carefully noted, also consumption of materials. If my battery fails as against others I will consent to pay £25 to any deserving charity, or I will present it to the Chemical Society or Telegraph-Engineers to purchase the successful battery for future experiments in their lecture rooms. I of course debar colourable imitations of my battery from competition. The arbitrator must be an electrician and chemist of reputation, and not pecuniarily interested in any battery system.

I also intend to submit a certain number of cells for trial as to their suitability for telegraphic or mining purposes, but as this would mean leaving them when charged with acids, &c., for at least six months, it would naturally have to be in connection with some telegraph company.—Yours, &c.,

WILLIAM WEBSTER, JUN., F.C.S., A.S.T.E.

6, Great St. Helens, E.C., 23rd Nov., 1887.

PUMPING BY ELECTRICITY IN COAL MINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been very much interested in reading a brief description, in your last week's issue, of the electrical pumping plant at Messrs. Locke's collieries, Normanton, which appears to be doing good work. We have working at these collieries what I believe to be the largest pumping plant at present driven by electricity. A pump delivering 114 gallons per minute through a head of 300 feet = 10·36 horse-power is placed more than a mile underground, and is doing excellent work. This is the third pump so working here, the first having been started more than four years ago.—Yours, &c.

FRANK BRAIN.

Trafalgar Collieries, Forest of Dean, 21st November, 1887.

SPRINGS ON TELEGRAPH WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: To prevent misconception on the part of any of your readers who may be disposed, from the illustrations published in your journal, pages 504 and 538, to judge that the "bow" and the "automatic insulating grippers" are the only features distinguishing my arrangement from that of M. Bardonnaut, it becomes necessary for me to state that within the helix of my springs is a further improvement in the shape of a simple automatic *restrainer*, which causes my regulator to withold its relief from the line wire until the stress has reached nearly one-half its breaking intensity, when my regulator begins to dispense its relief to the wire in so economical a manner as to always reserve for abnormal storms its full power of extensibility.—Yours, &c.,

FRANK CAWS.

Sunderland, 16th November, 1887.

ON TRADE DISCOUNTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If I am not overstepping the bounds of the courtesies of scientific journalism I should like to enter an earnest protest against the absurdity, as it seems to me, of dragging mathematical calculations, such as those given by Mr. Money-Kent in your current number, into a simple commercial transaction that any educated boy should be able to manipulate without the assistance of either pen or paper. Practical business men avoid long mathematical calculations in their every day transactions, not always because they are incapable of making them, but because they know how easy it is to make a slip in the middle, which will put the result wrong.

Mr. Money-Kent is in error in supposing that practical business men adopt a happy-go-lucky method of making their calculations; they do nothing of the kind, but they adopt simple rules that cannot easily be mistaken nor lead them into error.

I venture to give one for the benefit of your readers dealing with the case in point, and I would ask your readers to judge which rule they would prefer using.

My rule is as follows:—

Find the vulgar fraction corresponding to the discount to be allowed, and substract from its denominator a sum equal to the numerator; the result is the fraction required. Thus, 5 per cent. = $\frac{1}{20}$, requires $\frac{1}{19}$; 10 per cent. = $\frac{1}{10}$, requires $\frac{1}{9}$; 15 per cent. = $\frac{3}{20}$, requires $\frac{3}{17}$; &c., &c. It will be seen that it works to exactly the same figures as Mr. Money-Kent's *simple* formula; but I venture to think that whereas almost any educated boy of intelligence could run out the figures required in ordinary use in his head on my plan, a great many would be puzzled by Mr. Money-Kent's, particularly if preceded by the formidable calculation given.

If Mr. Money-Kent has a fancy for showing everything by means of curves, there is nothing to prevent him drawing a curve on my plan, after calculating a certain number of the principal discounts; but I would suggest as a better plan that he should let his office boy calculate the actual figures for each discount that he is likely to use and enter them in a table, which may be posted on a card and hung up in the office. I fancy there would be less liability to error on this plan always.—Yours, &c.,

SYDNEY F. WALKER.

195, Severn-road, Cardiff, November 15th, 1887.

THE COST OF ELECTRIC LIGHT FITTINGS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is refreshing to be told that "there is no need to go into the cost of silk-covered wire" (*see* "Mr. Haxell's letter to the *Daily News*," page 27, last week's *Electrician*). Will you be good enough to inform me if it is usual for respectable contractors to wire a house with the omnipotent "silk-covered" wire?—Yours, &c.

MECHANIC.

SOCIETY OF ARTS.

PROF. S. P. THOMPSON ON MERCURIAL AIR PUMPS.

At the Society of Arts, on Wednesday last, Prof. S. P. THOMPSON read a most interesting paper on "The History and Development of the Mercury Air Pump." It was doubtless a surprise to many of his audience to see in one of his diagrams the sketch of a pump made by Swedenborg in 1722, which was, though rude in form, exactly the same in principle as the well-known Geissler pump. Various improvements were successively introduced by Baader,

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Hindenburg, Edelcrantz up to 1855, when Dr. Geissler brought out a pump which may be considered as the first modern practical form. The next great stride was made in 1865, when Dr. Sprengel brought out his well-known pump with mercury dropping down a fall tube. Several modern improvements were described, including Mr. Swinburne's pump and a very simple valve by Meisens, also an ingenious rotating pump. The advantages of short falls and of exhaust into a partial vacuum instead of into the air were dwelt upon, and the well-known M'Cleod gauge described. Prof. Thompson concluded by pointing out that, as was so often the case with important types of apparatus, the mercurial pumps could hardly be said to be invented at all, but to have grown out of the combined efforts of a large number of workers.

In the discussion which followed, Prof. Crookes, after saying that his idea of a good vacuum had been continuously enlarging from that obtained by the ordinary mechanical pump to that now obtained by the most modern mercury pumps, pointed out that even in a vacuum of one-hundredth of one-millionth of an atmosphere, which might be expressed as $\frac{1}{10}$in. on a barometric column 200 miles high, there were some 10 billion molecules still left in each cubic centimetre, so that even at that degree of exhaustion we were at an almost hopeless distance from a true vacuum.

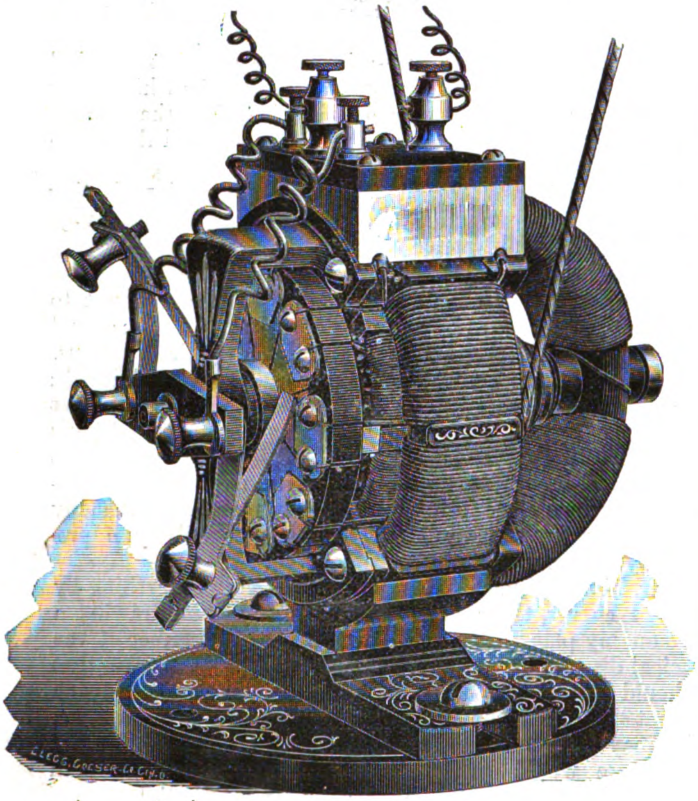

Fig. 1.—The Card Motor.

Mr. Swinburne differed from Prof. Thompson as to the use of the short pump, on the ground of difficulty in maintaining the partial vacuum into which the falls exhausted. He pointed out that the readings of the M'Cleod gauge were rendered doubtful owing to mercury having a perceptible vapour tension.

Dr. Ramsay thought that the gauge might also give false readings owing to the air sticking to the sides of the tube instead of all going to the top. He stated that to the best of his remembrance from some of his own experiments, he had found vapour tension of mercury to be about 2×10^{-7} atmospheres.

Mr. Boys said that when working with a Sprengel pump heated too hot to touch, he had noticed that the mercury appeared to be in far more intimate contact with the fall tubes, owing probably to the air being driven off them by the heat, and that the hammering of the falling drops of mercury was very much louder.

Mr. Mordey, as a proof of the excellence of a paraffin joint, mentioned that he had had a barometer tube sealed at the top with it, which had kept its Torricellian vacuum for the last nine years.

In his reply, Prof. Thompson said that one very great advantage of the short pump over the long one was that the mercury was never in contact with air except at a low pressure, and that consequently less air attached itself to its surface.

A cordial vote of thanks was given to Prof. Thompson for his interesting paper.

THE CARD ELECTRIC MOTOR.

The small electric motor illustrated in the adjoining figures hails from the United States, and is made by the G. F. Card Manufacturing Company, of Cincinnati. The apparatus measures 6in. by $7\frac{1}{2}$in. by 5in. in height, and weighs 9lb. It is wound in series for a current of $2\frac{1}{2}$ amperes. When used on a constant potential incandescent lamp circuit, a number of small lamps of lower voltage are connected in parallel with the motor, and a switch is arranged to regulate the speed of the armature by cutting these lamps out in succession. The circuit is broken before the last lamp is cut out.

The armature is shown in Fig. 2. The following description of its merits is furnished us by the makers :—" All the sections can be taken out and replaced without disturbing a wire; consequently, when the sections are worn on one face they can in a few minutes be reversed, so as to get the greatest wear out of the metal, or, if worn on both faces, new sections can be substituted. As can be seen by the figure, an observation can be taken on both brushes at the same time, to ascertain whether the current is being wasted by sparking, a convenience which will be appreciated by those having machines to look after. An experience of nearly a year in the use of a dynamo of considerable size, fitted with this form of commutator, enables the inventor to state that the differential wear, which at once suggests itself as an objection to such a device, is an entirely negligible matter."

PRIMARY BATTERIES FOR ILLUMINATING PURPOSES.

(Concluded from page 38.)

The Eclipse Battery.

The Eclipse primary battery, which is the invention of Mr. Henry I. Harris, was brought out in June last. It is a portable battery, and consists of a series of cells made of vulcanite, and filled with a solution

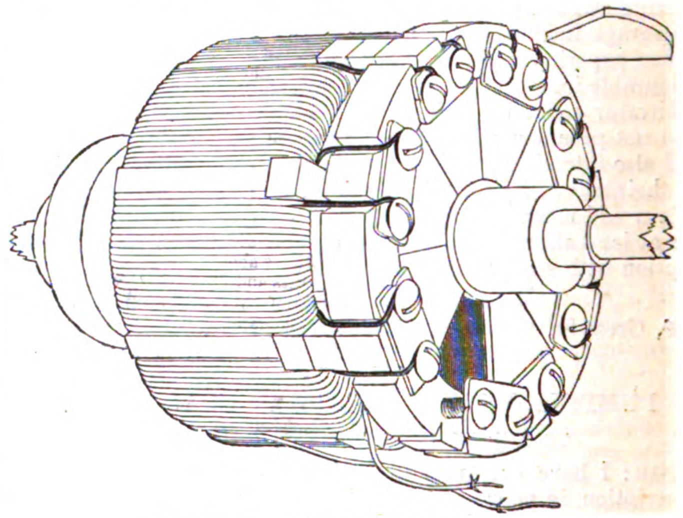

Fig. 2.—Armature of the Card Motor.

of sulphuric acid, in which is a plate of zinc as a positive. Within the vulcanite cell is a porous cell, charged with a solution of nitrate of soda, and in which is the negative element—a carbon pencil. A $2\frac{1}{2}$ candle-power glow lamp for twelve hours is said to cost 1d. The Eclipse battery is said to be very low in price, and to cost only 2d. to charge, the charge lasting for twenty-four hours. The lamps have also been in satisfactory use on twenty omnibuses belonging to the London Road Car Company for two months.

The Newton Battery.

About the same time that the Eclipse battery was introduced to public notice, the Newton primary battery was also brought out and inspected by the author. Since then the disposition of the elements has been altered by Mr. Charles M. Newton, and sundry other modifications have been introduced by him. In this battery the negative plate is of iron, the positive is zinc, the depolariser a plate of oxide of lead, and the exciting fluid a caustic alkali. Each cell of the original battery consisted of an outer case of iron forming the negative plate of the cell. On the bottom of this the depolarising material was spread. Above the latter was placed a diaphragm of parchment paper turned up at the edges so as to divide the cell into an inner and an outer compartment, and at the top, resting on glass insulators at the four corners of the cell, the zinc positive plate was laid horizontally. The alkaline solution was then poured into both compartments and the cell was ready for use. Binding screws were of course attached to the two plates, and that on the zinc was protected at the surface of the liquid. This battery has been tried and satisfactorily reported upon by Dr. R. M. Walmsley, F.C.S., who stated that a brilliant

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and steady light was obtainable for 120 hours without attention. He also stated that the local action was practically negligible.

In the improved form of battery which is being brought out by the New Electric Light Syndicate the electrodes are zinc and iron. The cell, which is of iron, contains alternate vertical plates of these metals, the latter having attached to their surfaces the depolarising plates made of oxide of lead. The exciting fluid with which the cell is filled is a solution of caustic alkali. At starting the electromotive force is stated to be 0·69 volt per cell, which, after 130 hours' continuous run at work, only falls to 0·61 volt, and during the same period the current will merely decline about 13 per cent., and is perfectly steady for the first fifty hours. These statements are given on the authority of Dr. Walmsley. When necessary, the battery is recharged, the spent materials being taken away to be regenerated, and the depolarising plates reoxidised while the solution is, by a special process, separated from the dissolved zinc. The solution is reserved for further use, and the zinc is converted into a sulphide for use in paint making.

The chemical action which takes place in the Newton battery has been reported by Mr. Harold Senier, F.C.S., to be as follows:—"The solution of caustic soda gradually dissolves the zinc, forming zinc oxide, which is again dissolved in the solution, and at the same time hydrogen is set free. The free hydrogen is given off from the surface of the iron, and while in the nascent condition robs the lead oxide of its oxygen, with which it forms water, and so prevents the battery polarising. The depolarising action is the only part played by the lead oxide. By this action the litharge is reduced to the form of black sub-oxide, and a portion to the metallic state. The iron is quite unacted upon. The zinc is dissolved to the extent of one-third its original weight. The solution of caustic soda, except that it contains a certain proportion of oxide of zinc in solution appears practically unaltered."

With medium and small installations accumulators are used, and the current is utilised in glow lamps which have been specially designed for the Newton battery. The prime cost of a battery for supplying a current to 50 lamps of 10 candle-power each, with a current of 40 amperes and an E.M.F. of 15 volts, is put at £90. 9s., and its maintenance for 130 hours at £4. 7s.—which is equal to 1s. 9d. per lamp for 130 hours light.

The D'Humy Battery.

The next battery for notice in the order of its appearance before the public is that of Mr. P. R. D'Humy, which was brought out in August last. In this battery, which is known as the Water Primary battery, the positive element is iron in the form of a grid, so that a large surface of metal is exposed within a small compass. The negative element is carbon, and is immersed in nitric acid, the positive element being immersed in water. The cell is divided up into compartments by porous diaphragms, and the acid percolating through the diaphragms permeates and acidulates the water in which the iron electrodes are placed. The installation inspected by the author represents on a small scale a central station, for Mr. D'Humy proposes to apply his system to central lighting. It comprises a battery of 20 cells, each measuring 2ft long by 1ft. wide and 1ft. deep. The battery occupies a floor space of about 11ft. by 5ft., and the current produced is stored in 40 accumulators specially designed by Mr. D'Humy. Each accumulator is about half the size of a cell. This battery is stated to be equal to 35 volts and 40 amperes.

With regard to the cost of maintenance of this battery, according to a report by Messrs. Gooch and Varley, 1 kilogramme (2lb.) of nitric acid consumed in the water battery—and costing, roughly, 4d.—produces a light of 366 candle-power for one hour. One lamp of 10 candle-power, therefore, will cost rather less than half a farthing per hour. For generating the current on the premises Mr. D'Humy has devised a small battery enclosed in a neat cabinet 5ft. high by 3ft. wide and 2ft. deep. The lower portion contains thirty-two cells, the positive element here being a new alloy, invented by Mr. D'Humy. The plates can be raised out of their solutions, and the battery thus kept at rest when light is not required. There is also a simple arrangement for discharging and replenishing the cells. The water battery certainly constitutes a departure in primary battery practice, and by the light of Mr. D'Humy's installation the invention appears to possess points of ingenuity and merit. It has, however, one drawback in the smell emitted by the nitric acid.

The Friedlaender Battery.

A marked improvement has recently been made in the single-fluid bichromate battery by Mr. Albert Friedlaender, of Berlin, who took advantage of the circumstance that chromic acid is now manufactured by a new process at a price at which it can be used for this purpose. Chromic acid can now be purchased for from 9d. to 1s. per lb., whereas it formerly cost from 4s. to 5s. per lb. In the ordinary bi-chromate battery the depolariser is a solution of either bi-chromate of potash or bi-chromate of soda, in which the carbon and the zinc elements are immersed. These batteries are found to clog, owing to the depolariser having a base, but this objection does not exist with chromic acid. Another important advantage is that chromic acid is much more soluble in water than bichromate of potash, and thereby a much more powerful depolariser can be used in a small cell. The Friedlaender battery has several good features in its mechanical arrangement. It is a small battery, and, with a lamp attached to it, forms a useful and convenient portable lamp, one of which is exhibited on the table. It consists of an outer case of ebonite 8in. high by 5in. square in plan. The battery is divided vertically into five cells, and the elements—which are zinc and carbon strips—are arranged in five pairs, and are attached to a small horizontal spindle placed at the back of the battery near the top. One end of this spindle is fitted with a worm-wheel motion, actuated from a thumb screw on the outside. The depolariser is a solution of chromic acid, the acid being supplied as a powder and dissolved in water. The level of the liquid is kept below the spindle to which the elements are attached, and when the battery is not in use these latter are maintained in a horizontal position clear of the solution. To put the battery in action the thumbscrew is turned and the elements are gradually immersed in the depolariser. Two advantages result from this arrangement; in the first place, waste is prevented while the battery is out of action, and in the second, the gradual immersion enables the current to be regulated, and the light graduated and set at any point, from a glimmer to the full capacity of the battery. The zinc and carbon strips are attached to the spindle by set screws, so that the renewal of the zinc can be easily effected in a minute or two. The lamps used are Swan glow lamps of 8 volts by 1 ampere, or between 3 and 4 candle-power. The cells are easily emptied of their spent contents and re-charged with the solution. Each charge costs between 3d. and 4d., and will give a steady current for two and a-half to three lamp hours. The lamp can be attached to the battery either at the front or on the top, or it can be removed and the battery used for surgical or experimental purposes. These batteries are being introduced into this country by the General Electric Apparatus Company previously referred to.

There is, however, another miner's lamp which has also been prominently before the public of late, and this is the Edison and Swan Company's safety lamp. By the kindness of the company, two of these lamps are on the table. The battery here, however, is not a primary but a secondary battery, and the lamp consists of four small accumulators enclosed in a teak box, strengthened with metal bands, and having a small glow lamp mounted on the side of the case and protected by a strong glass. The case is fitted with a hinged lid, secured by a cross bar, fastened with a safety nut, and having a swivel handle. The lamp measures 7in. by 4½in., and it weighs ready for use 6lb. 13oz. The lamp is opened by unscrewing the safety nut and raising the hinged lid, when the battery can be withdrawn. The four cells composing the battery are joined in series, the terminals being brought down the sides of the battery in the form of two contact plates, which, when the battery is put into the case, come in contact with two corresponding plates in the case, and thus convey the current to the lamp. One charge of the battery will last from ten to twelve hours. The battery is recharged from a dynamo machine. With a sufficiently powerful machine several hundreds may be charged at once. The lamp can also be fitted with a fire-damp indicator, which, it is stated, will indicate a percentage of fire-damp or choke-damp as low as one-tenth of 1 per cent.

Conclusions.

The author has now described sixteen primary batteries, being all that have come under his notice, and has given such particulars concerning them as the limitation he has prescribed for the subject will permit. It might be expected that he should now proceed to analyse the various systems, and to pronounce an opinion upon their relative merits. Two things stand in the way of this. In the first place, the present paper has been prepared at short notice, to meet an emergency, and was only commenced three weeks since, so that there has been neither time nor opportunity for such a careful examination to be made as should entitle the conclusions drawn from it to respect. In the next place, the author conceives that no single person should undertake the task of examination. Electric lighting is still but in its infancy, and no system ought to be either condemned or approved without very careful and exhaustive trial. To this end the various batteries should be placed unreservedly in the hands of three disinterested professional men—an electrician, a chemist, and an engineer, for all three professions are represented in every primary battery system. The author is not quite sure that the various patents should not undergo a preliminary investigation by a patent agent. We are, however, fortunate in having among us to-night several eminent electricians, and from these masters of the science, as well as from the inventors of the batteries, we may hope to hear something more respecting the practical value of these batteries than the author has been able to give in his paper. Broadly and generally speaking, it appears to him that it has yet to be proved that any one of the batteries could be applied to the partial illumination of moderate-sized houses—for that is what is really wanted—with commercial success. For large establishments there is evidence based on practical use that the Upward, the Holmes, and the Lalande batteries are suitable—that is, where cost does not stand in the way. It has not, however, been shown to the satisfaction of the author that any one of them can be used economically for lighting the principal rooms in more modest residences—in a word, for the general public. The author has been met by some with the statement that the general public could at the present time be supplied with electric lighting by primary batteries as cheaply as they are with gas, but that until clients from the wealthier classes, to whom expense is not an object, have been exhausted prices will not and should not be lowered. The author conceives this course to be a mistake, for the process of exhaustion will be slow. Oil lamps and candles are still used in the principal rooms in numbers of mansions, and in the residences of the upper classes, and will continue to be used owing to their effective appearance as works of art—as many of them are—and to the greater purity of the air resulting from the combustion of oil as compared with that of gas.

To popularise the electric light—and to popularise it is the only way to make it pay—it must be cheap and efficient. By cheapness is to be understood either a small first cost and a correspondingly small cost for maintenance, as in the case of a battery placed in the house, or a moderate charge for the supply of the current, as in the case of a central distributing station. The lamps must be adaptable to the present gas fittings, and the cost of the light must be but little in excess of that of the gas of the district. The author does not for one moment ignore the advantages of the electric light from a hygienic or a domestic point of view, he is but too familiar with the unpleasant atmosphere which results from burning gas even with the best burners and in ventilated rooms, although his lucubrations are generally conducted by the aid of an oil

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lamp. The general public, however, will in the main continue to use the present ordinary methods of illumination, however defective they may know them to be, rather than adopt any new system which entails extra cost, however satisfied they may be that positive advantages are to be gained from it. Men will weigh the extra cost against the extra advantages, and in the majority of cases the former will be allowed to outweigh the latter.

That there are merits in many of the primary systems described—that is, those which have survived their introduction to the public—there can be no doubt, some possessing points which are absent in others. And be it remembered that the list of primary batteries is not exhausted by those described by the author. It might therefore be desirable that a fusion of interests should be effected, and that a committee of independent electricians, chemists, engineers, and sound commercial men, be formed to practically test each battery to destruction. Out of the results might be formulated a system which would meet all the requirements of the general public, and which might eventually be the means of saving the proprietors of those systems which fell short of the mark from absolute loss. The results of this method of applying the doctrine of the survival of the fittest would perhaps press the least inconveniently upon those doomed to suffer by this inexorable law. Of course the author can quite understand every inventor present assuring himself that he is not going to be an absolute loser, but that he is going in to win. The author can only sincerely hope it may be so. Every battery represents a considerable expenditure of time, money, and anxious thought, and every inventor deserves, if he does not achieve, ultimate success.

DISCUSSION.

Mr. W. H. Preece said that his remarks were not intended in the least degree to be critical, and he hoped they were not conceived in an unfair spirit; but he must at once confess that he was to a certain extent an opponent to the introduction of primary batteries for the purpose of distributing light for domestic uses. There were few who had had more experience as to the behaviour of primary batteries than he had, having been acquainted with them for thirty-four years, and he was equally sure that any attempt to utilise them for any such extensive purpose as the lighting of mansions and smaller houses must end in disastrous failure, although there were other uses to which they might be applied with advantage, and, he hoped, with pecuniary success. So many primary batteries had been brought before the public during the last few years that the subject had become nauseating. Most of these, however, possessed peculiar and distinct features. They were almost invariably surrounded with a halo of mystery. There was the depolarising agent, which was a secret—an acid or a solution that was hidden in an atmosphere of Greek or Latin, the result being that all that people knew about them was gained from the high falutin statements put forth in prospectuses and interested descriptions. But amongst the numerous failures there had been one or two successes. One very promising battery that at some time would certainly make a stir was that which Mr. Nursey had described as the Holmes and Burke battery; another which was a distinct departure was the Upward battery, and why that one had not been more practically developed he had a great difficulty in understanding. It seemed to meet the want for something which would come between that point where a gas engine or a secondary battery might be introduced and the point where a small battery could be used for mining or other similar purposes. It had not yet received that development it deserved. Mr. Nursey's paper dealt largely with the theoretical side of the primary battery question, but was there any gentleman in the room who could tell them the practical result of twelve months', or of six, or even three months' continuous work? That was what practical men wanted more than anything else to know. The field in which primary batteries were going to make a stir in the world was not that of house lighting; it was in supply of safety lamps to those who endangered their lives for our comfort. There was no greater want in this age than that of some handy portable, convenient light that men could carry about with ease and safety in mines. He mentioned as a fact within his own knowledge that some time ago 2,600 electric safety lamps had been ordered for collieries in the neighbourhood of Cardiff.

Mr. March, accepting Mr. Preece's challenge, described the practical working of the Holmes-Burke battery for a period of more than a few months. He said that two years ago he had installed 40 lamps of 10 candles supplied by a Holmes-Burke battery, and that installation had worked with perfect satisfaction to its owners ever since. The cost, of course, was more than gas. He thought they would be too sanguine as yet to expect electric lighting to be as cheap as gas. He put down the cost of the Holmes-Burke battery as being something like double the price of gas at 3s. or 3s. 6d.

After a few words from Mr. Clifton, who proceeded to give a description of the Eclipse battery,

Mr. Ross said that his battery was a zinc and carbon one, and the only mystery there would be in regard to the solution was that he had occasionally called his oxidising liquid "Eureka;" but he was quite prepared to explain what the liquid was. It was a very economical one, being composed of three parts of muriatic acid, three parts of water, and one part of another strong oxidising agent. He generally used a peculiar kind of fuming nitric acid—that was to say, what was usually called nitrous.

Mr. Fergusson said he was interested in the Lalande battery, with which in the year 1886 quite 1,000 lights were run. The only point in regard to the Lalande battery as to which there had been any doubt was in reference to the getting back of the zinc. There was no doubt that that could be effected. They were getting it back now in the form of metallic zinc of a very pure quality, and he hoped shortly to be able to send a sample to Mr. Preece especially for Post Office purposes to prevent local action, and he thought that when Mr. Preece had tested that sample it would convince him that though it was possible to use primary batteries for domestic lighting that the residual products were also of value.

Mr. Upward said that his battery had been employed at the Manchester Exhibition, University College, Liverpool, and at Messrs. Woodhouse and Rawson's offices in Queen Victoria-street as well as by the Government of Valparaiso. Since it had been first introduced it had been very much simplified. The great object had been to get over the large number of chlorine connections.

The Earl of Galloway gave some interesting particulars in connection with secondary batteries furnished from the working of the Elieson locomotives on the tramways at Stratford.

Mr. Binswanger endorsed the remarks of Mr. Preece, and stated that the Pollak battery, in the introduction of which he was concerned, he had found to fail for the purpose for which it was intended. He was now interested in the Friedlander battery, the pretensions of which were very modest, and which was intended only for table and medical uses.

Mr. Pearson said that he was present to represent Lord Onslow as an intending purchaser if any one would put before him a battery which would replace that which had been in Lord Onslow's house for some time, but which had proved a failure. He was afraid that he should have to go away from the meeting with the impression that he had when he came to it, that primary batteries were not adapted for general house lighting.

Mr. FitzGerald said that in common with other electricians he had been astounded at the statements which had been put forward on behalf of a number of primary batteries which had been disinterred from the limbo of past failures, and which had been experimented upon twenty-five or thirty years ago, and which were at that time condemned. He must, however, except from these strictures the chlorine battery of Mr. Upward, and also the Lalande-Chaperon battery, which had some extraordinary properties, and which in a higher degree, perhaps, than any other battery possessed the capacity of supplying large currents—being condemned only by its E.M.F.

Mr. Rawson said that the reason why the Upward battery had not been more heard of during the last year was that he preferred to make it as perfect as possible before putting it in the market. In its present state it was the result of a great many years' work on the part of Mr. Upward, and he believed they might look forward to twelve or eighteen months' harder work before they would get it into a form when they might say it was fit to take the place of a dynamo or gas engine for lighting houses with 50 or 100 lights.

After some remarks from Dr. Fleming, the proceedings terminated.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

STUDENTS' MEETING.

A meeting of the students of the Society of Telegraph-Engineers and Electricians was held on Thursday, the 17th inst., Prof. Perry, M.E., D.Sc., F.R.S., in the chair.

Mr. J. Rance, jun., opened a discussion upon Profs. Ayrton and Perry's paper, "Modes of Measuring the Coefficients of Self and Mutual Induction," explaining various forms and uses of the secohmmeter, including the latest form, the reversing secohmmeter, the advantages claimed for this form of instrument being (1) The sensibility is doubled; (2) may be used when the magnetic circuit is closed; (3) the battery circuit is broken for a very short time; the E.M.F., therefore, does not change much.

Reference was also made to Mr. Sumpner's paper, "The Measurement of Self-Induction, Mutual Induction, and Capacity." Owing to the kindness of Profs. Ayrton and Perry many instruments and diagrams were exhibited. The discussion was maintained by Messrs. E. W. Smith, Cooper, Bate, Dykes, Lamb, and Prof. Perry.

After thanking the Chairman for presiding, the meeting terminated.

The next Students' Meeting will be held on Thursday, December 1.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

15,600. W. Price and J. Gerrard. Preston. An improved electric circular switch railway. November 15.

15,640. W. H. Scott and A. E. Paris. London. An improved method for regulating the electromotive force of secondary circuits. November 15.

15,653. H. H. Lake. London. Improvements relating to electrical apparatus for signalling in railway trains and to coupling devices for use therewith (The D. M. Electrical Train Signal Co., Incorporated, United States). Complete specification. November 15.

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15,660. A. J. THOMAS. London. Improvements in electric clocks. November 15.

15,703. J. COURT. London. A galvanic battery for medical purposes. November 16.

15,717. C. A. RANDALL. Brompton. Electrical date and time stamp. November 16.

15,721. A. W. ARMSTRONG. London. An electrical movement or mechanism for the automatic sale of goods. November 16.

15,726. N. K. CHERRILL. London. Improvements in conductors for use in incandescent electric lamps. November 16.

15,730. J. VAUGHAN-SHERRIN. Kent. Improvements in galvanic batteries (complete specification). November 16.

15,736. W. R. LAKE. Improvements in electrical indicating or signalling apparatus (C. Grivolas, France). November 16.

15,754. W. J. S. BARBER-STARKEY. Manchester. Improvements in the electrolytes of secondary voltaic batteries. November 17.

15,760. W. WEBSTER. London. Improvements in the electrolytic treatment of sewage and sea-water for the production of certain products therefrom and apparatus therefor. November 17.

15,779. A. J. JARMAN. London. Improvements in the construction of electrical motors. November 17.

15,801. W. H. BECK. London. Improvements in incandescent lamps (A. M. Michel, France). November 17.

15,858. W. MAIN. London. Improvements in dynamo-electric machines and electro-motors (complete specification). November 18.

15,883. W. G. ADAMS. London. Electric safety lamp apparatus. November 18.

15,887. A. W. ARMSTRONG. London. An improved electrical automatic delivery box. November 19.

15,891. W. H. DOUGLAS. Birmingham. Improvements in instruments for measuring electrical currents. November 19.

15,922. A. COLEMAN, H. F. JACKSON and E. L. DUDLEY. London. An improved spring jack for telephonic and other electrical purposes in which it is desired to change or switch a current from one conductor to another. November 19.

15,939. W. WEBSTER. London. Improved apparatus for the electrolytic treatment and other impure liquids. November 19.

15,943. O. C. D. ROSS. London. Improvements in galvanic batteries. November 19.

15,965. A. S. DUNN. Glasgow. A new or improved apparatus for use in erecting or renewing telegraph, telephone and other wires. November 21.

15,985. E. BERGHOLT. London. Automatically diverting and restoring the course of an electrical current. November 21.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

November 19th, 1887.

15,722. J. Y. JOHNSON. London. Improvements in electric telegraphs (A. M. Rosebrugh, Canada). December 1, 1886.

November 23rd, 1887.

1,738. C. D. ABEL. London. Improvements in dynamo-electric machines (the firm of Siemens and Halske, Germany). February 3.

PATENTS SEALED.

November 15, 1887.

13,641. B. J. B. MILLS. London. Improvements in the means for indicating and for regulating the electrical potential in systems of electrical distribution (J. W. Howell, United States). October 25, 1886.

14,568. A. HOWAT. Manchester. Improvements in electric safety lamps. November 11, 1886.

10,866. C. ACCIOLI DE AZEVEDO BASTO. Brazil. An improved motor. August 8, 1887.

November 18, 1887.

11,720. C. P. SHARPLEY. Staffordshire. Improvements in couplings, chiefly applicable to railways, vehicles and their fittings, such as brake pipes or rods, electric conducting wires and the like. September 15, 1886.

14,106. C. POLLAK and G. BINSWANGER. London. A method and and apparatus for conducting electricity to moving vehicles. November 2.

14,489. C. SMITH, London. Improvements in apparatus for lighting railways, carriages, and tramcars by electricity. November 9, 1886.

14,563. J. S. SELLON, Kent. Improvements in secondary batteries. November 10, 1886.

10,933. D. S. ROBERTSHAW and R. F. SUNDERLAND, Yorkshire. Improvements in means or material employed for insulating electric currents. August 10, 1887.

SPECIFICATIONS PUBLISHED DURING THE MONTH.

13,971, 1886.—H. R. FISHER. Electric portable battery and lamp. (Price 8d.)

12,222, 1886.—R. J. RUDD. Electric apparatus for indicating time. (Price 8d.)

16,440, 1886.—W. J. MACKENZIE. Electric arc lamps. (Price 8d.)

16,662, 1886.—R. P. SELLON. Automatically regulating electric generators.

16,908, 1886.—W. ARMSTRONG. Effecting electrical signals between the occupants of cages, hoists, &c. (Price 8d.)

893, 1887.—G. W. HOOK. Electrical billiard marking repeater and indicators. (Price 6d.)

COMPANIES' MEETINGS.

South of England Telephone Company (Limited).

A half-yearly general meeting of this Company was held at Winchester House, No. 50, Old Broad-street, yesterday, under the presidency of Mr. D. Owen Bateson.

The SECRETARY (Mr. Fred. L. Robinson) having read the notice convening the meeting,

The CHAIRMAN said: In compliance with the resolution passed at our general meeting in June last we have called you together to-day. I think, however, that we could have told you everything relative to the Company's progress by circular instead of giving you the trouble to attend personally; but as far as your Directors are concerned, they have not the slightest objection to the meeting, and it affords them the opportunity of rendering an account of their stewardship during the past half year, and of answering any questions upon which the shareholders desire information. The time under review has been extremely uneventful; indeed, I may say we are in the happy condition of that country that has no history. We have met with no disaster of any kind, as far as I am aware, and our progress in new work has been to a satisfactory extent. Our system has withstood the gales of the autumn, proving that the lesson taught by the collapse last winter has been well learnt. The number of our exchange lines has increased by 186 and private lines by 25, and our gross rentals show £1,500 increase for the half year. We have laid trunk lines between the towns of Brighton and Lewes, Brighton and Shoreham, and between Margate, *via* Broadstairs, and Ramsgate. This latter line is intended to be connected with Westgate as soon as we can get wayleaves through. The Brighton and Lewes line is an instalment towards Eastbourne. At the moment the latter route is suspended—temporarily we hope—consequent on wayleave difficulties, which we trust may be got over ere long. The Margate and Ramsgate exchanges are in process of development, and we think they give good prospect of success eventually, though this year we have great complaints of the unprofitableness of the last season in both places. Our centres north and west of London are doing a good steady business. Reading makes satisfactory progress, and Cambridge is doing very well. I am sorry to say that Oxford lags sadly behind the sister University, and we find much difficulty in getting along there. Northampton, Norwich, and Ipswich are doing pretty fairly, though perhaps hardly as well as we could wish. We have great complaints of the badness of trade in these districts. Our other stations are well seen to, and whenever we see a prospect of doing any paying work our energies are devoted to looking after it. I am glad to say that as a rule the public bodies in the various towns we are in welcome us in the light of public benefactors, and give us valuable assistance. Here and there, however, individuals give us some trouble and impede our progress; but, upon the whole, we have really little to complain of on this score. Our relations with the Post Office are of the most amicable kind. We never have any controversy with this branch of the public service. I must also bear my testimony to the kindness and consideration of the various railway companies in our district, both in granting us wayleaves, &c., and in renting lines from us where they can be made useful. We always endeavoured to put them on the most favourable terms possible as regards cost. I regret to say we have come no nearer to a junction of our system with that of the United Company in order to enable our subscribers to converse with London, and *vice versâ.* We have loud and continuous complaints that we are unable to effect this most desirable end, and have made representations to the parent company about it. As you are aware, we do not produce any financial statement at this period of the year. I may, however, state that your Directors are satisfied with the progress of the business, and they have every expectation that at the annual meeting in the spring of next year they will be able to give a good account of themselves. I have no resolution to propose on this occasion.

Mr. WM. ROE (Ipswich) observed that at the last meeting he had to take up a position somewhat in opposition to the Directors' views; but he was not in that position that day. He had endeavoured, in conjunction

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with a friend, to get a trunk line established from Ipswich to Stowmarket, and he felt convinced that if they could succeed in that they would be able to get a trunk line from that point to Felixstowe. They, however, found their efforts rendered difficult in consequence of the terms asked by the Company. Some merchants hesitated because they were required to pay £10 for the Exchange, as well as £6 for the trunk line. That was £16 a year. He was very anxious to get the trunk line to Stowmarket, and he asked whether some modification could not be made in the terms referred to. If that could be done he felt that they could obtain the necessary permission for the line to Stowmarket.

The CHAIRMAN said they would be glad after the meeting to talk the matter over with Mr. Roe. The Directors had been trying to obtain the line in question for the last two years, and they were anxious to run it as soon as ever they could see a paying price. They could not run speculative lines, and his experience was that if once they ran a line without getting the orders before, they never got them after.

Dr. ELLIS (Eastbourne) said he thought the account of the six months' working should satisfy any shareholder in the Company. If such rate of progress went on, there was no doubt whatever that the success of the Company as a dividend-paying one was assured, and that they could look forward to an era of steadily increasing prosperity. He thought it was advantageous that they should meet once every six months. There were one or two points to which he would like to draw attention. He thought it would be very advantageous if there could be an extension of the lines to the post offices throughout the district, so that telegrams might be sent direct from the houses in the suburbs. In many cases where the houses were at a considerable distance from the telegraph offices, particularly in the winter, that would be a great boon. The Chairman had referred to the terms on which they stood with the railway companies. He thought that every railway station should have a telephone—at all events, that all first-class stations should have telephony in their offices. He gave an instance which had come under his notice of the importance of this—a doctor having been communicated with by means of the telephone, and brought within a few minutes to the assistance of a gentleman who had fallen down in a fit at the station. He had heard that in a neighbouring town to Eastbourne the Company had experienced great opposition to the introduction of the telephone unless certain special facilities were given to certain people, and that there had been some threats about cutting the wires. He was sorry that a suggestion which he made at the last meeting had not been acted on—that the Directors should do something to give information to the general public as to the working of the telephone. There seemed to be a great deal of ignorance on the subject, and when he had invited some of his acquaintance to speak through his telephone they had declined, and in a manner as if there was something uncanny about the instrument. Again, in the case of Hastings people said that they wanted underground wires; but such a wish could only have been inspired through ignorance, for the cost of underground wires would be so great that an exchange at Hastings could not pay.

The CHAIRMAN, in replying, stated that with reference to telephones at railway stations, the Post Office objected, and they had a voice in the matter. They had been trying very hard to get a telephone placed at Brighton station, but they could not succeed. He had been down to Brighton two or three times to see whether they could not get one as near as possible to the station. The authorities of Hastings had thrown a certain amount of difficulty in their way; but the opposition there had been more particularly from private individuals, who had had perfect information with respect to the difficulty and to the expense of going underground. Only last week he was at Hastings on the subject. He was almost afraid that some day they might have their wires cut, but he could not agree that it was desirable that they should let their wires be cut if they could induce a more favourable feeling. It was to be remembered that there was the cost of replacing the wires, and that as soon as the man's wire was cut he considered that his rental ceased.

Dr. ELLIS said that what he had meant to convey was that he would rather allow a man to cut the lines crossing his property than give way to him—than, for instance, let him have a wire free.

The CHAIRMAN said he fancied that such a matter as that must be left to the discretion of the Directors. Sometimes a line was absolutely necessary for them. They had the greatest difficulty as to crossing Warrior-square, Hastings, and he did not know whether they would have to go underground. They had 16 or 17 wires going over Warrior-square, and they had notice at present to remove them. If they saw their way to giving information to the public in regard to the telephone, as Dr. Ellis had suggested, they would be very glad to do so.

Mr. ROE said he thought a great increase of business would follow if they could put private residences in the suburbs on the telephone at a smaller cost than commercial people. Such persons would communicate with those tradespeople who had the telephone, and other tradespeople, seeing that, would then desire to have the same means of communicating with customers.

The CHAIRMAN said they tried to get as many suburban people on the Exchange as they could, but the further a man was away from the Exchange, the more expensive it was to put up a line for him. As a rule they could not very much reduce their rates, which were now lower than those of any other company in the country. They had been trying latterly to establish call offices with call boxes in the outskirts of towns, and in towns also, where any one could use the telephone on payment of a small fee—threepence or sixpence, according to distance.

Mr. KLENCK expressed his belief that the difficulty at Hastings would be very much alleviated if a deputation from the Board went there. He was connected with a certain company, and a difficulty arose with the authorities at Bristol. A visit from the Directors resulted the removal of the difficulty.

The CHAIRMAN stated that only last week he was at Hastings, but the objection to going over Warrior-square was not on the part of the Corporation.

A SHAREHOLDER: You must go round it.

The CHAIRMAN replied that for the last two years they had been trying to get wayleaves round it. They could get on at the west side of Warrior-square, but they could not get an attachment on the east side, where one proprietor objected.

Mr. STEWART said he had no doubt that the Directors would succeed, through friendly negotiations, in removing the difficulty which had arisen.

The meeting then terminated in the usual manner.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 18th inst. amounted to £4,443.

GERMAN UNION TELEGRAPH AND TRUST COMPANY.—The directors of this company report to the shareholders that the German Government have offered to purchase the cables and property of the German Union Telegraph Company of Berlin at a price which the directors reckon, after payment of expenses of liquidation in Berlin, will leave about £9. 10s. or £9. 15s. per share for the shareholders of the German Union Telegraph and Trust Company (Limited), payable in January, 1889. The dividends in respect of profits for the year 1887 will be paid at the usual time—viz., interim in January, 1888, and final in March, 1888. It is estimated that these dividends will yield from 7 to 7½ per cent. on the shares of this company. The directors recommend the acceptance of the offer of the German Government.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended November 18th were £3,595 (after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company).

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half-month ended 15th November are £2,609, as compared with £2,129 in the corresponding period of 1886. The July receipts, estimated at £4,762, realised £4,851.

NOTICE OF REMOVAL.—Messrs. Duncan Brothers, engineers, of 32, Queen Victoria-street, E.C., intimate that on and after the first day of December their business address will be 2, Victoria-mansions, Westminster, S.W.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Nov. 23.		Business Done Week Ending Nov. 23. Highest.	Lowest.
Anglo-American	38,	39	38	—
Do. Preferred	62½,	63½	63¾	63½
Do. Deferred	14,	15	—	—
*Brazilian Submarine	11½,	11¾	11 9-16	11⅜
Cuba	11¾,	12¼	12 3-16	11¾
Do. Preference	18½,	19½	—	—
Direct Spanish	3½,	4	3⅝	—
Do. Preference	8,	9	—	—
Direct United States Cable	8¾,	9	—	—
Eastern Telegraph	11½,	11⅝	11 5-16	11 3-16
Do. 6 per Cent. Preference	14,	14½	14½	—
Do. 5 per Cent. Debentures, 1899	106,	109	—	—
Eastern Extension	11¾,	12	12⅛	12
German Union	9¼,	9¾	—	—
Globe Telegraph and Trust	5½,	5¾	5 11-16	5⅝
Do. Preference	13⅛,	13⅜	13 5 16	13 3-16
Great Northern	13½,	14	13 15-16	13¾
Indo-European	36,	38	37½	36¾
Reuter's	8,	8½	8¼	—
Submarine	145,	155	150	149
West India and Panama	1,	1¼	1⅛	1 1-16
Do. 1st Preference	9¾,	10¼	10¼	9⅞
Western Brazilian	7¾,	8	—	—
Western Union 7 per Cent. 1st Mortgage	117,	123	—	—
Do. 6 per Cent. Sterling Bonds	101,	104	—	—

TELEPHONES.

†Consolid. Telephone and Maintenance	9-16,	11-16	—	—
Oriental	¼,	⅜	¼	—
United Telephone	12¼,	12¾	12 9-16	12
United River Plate	4½,	5	5	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	2,	2½	—	—
Do. (fully paid)	3,	4	—	—
Swan	1¼,	1½	—	—
Maxim Weston	3-16,	5-16	3-16	—

MISCELLANEOUS.

Telegraph Construction	87½,	38½	37⅝	57¼
India Rubber, Gutta Percha and Telegraph Works	21,	22	21½	21¼

* xd. and bonus. † xd. 1s. return of capital.

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THE ELECTRICIAN:

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NOTES.

The question, What is an Electrician? was asked at the Electric Club last month, by Dr. Leonard Waldo, of Yale College, U.S., but was not precisely answered either by himself or the gentlemen who discussed his paper, the prevailing notion being that, like the question, What is a Philosopher? very much depends upon what you mean by it. The nearest approach to a definition, we are gratified to notice, was given by our countryman Professor Forbes, who happened to be present, and who told his audience that an electrician pure and simple is a physicist, but that the electrician of whom they were talking is an electrical engineer or an electrical inventor—two classes of persons by no means necessarily the same. Mr. Swinburne, also one of the guests, seems to think otherwise, for he asserted, with more fluency than accuracy, that we turned out in this country accomplished electricians at the rate of about a dozen a week, and would be glad to export them to supply the American market. Well, if they have no objection, we have none to offer, provided the Americans will send over to us the surplus electrical work which at present they cannot find electricians enough to perform. We rather think we should not be the losers by this reciprocity.

Although disparaging things are sometimes said of our American kinsmen's science, there is no gainsaying their practical good sense, a sample of which will be found in the *School of Mines Quarterly* (New York) for last month. Its article entitled "What are the Requirements for a Course in Electrical Engineering at a Technical School?" ought to be read by every Englishman interested in this subject, and especially by those (if any such there be) who are inclined to dissent from the views put forward in our own leader last week. Starting from the proposition that "the commercial field of the physicist-electrician *by itself* is very limited," the writer, after careful discussion of the whole subject, arrives at a conclusion almost identical with our own, namely, that the rising students of electrical engineering "should be trained first as mechanical engineers, and upon that foundation the special electrical structure should be erected." Finally, he asks the question, whether in these days of electrical industry it would not be well to "make the course and degree of the mechanical engineer in the university cover as much of electrical knowledge in addition to its other requirements as would render its graduates competent for the electrical positions which they are likely to be called to fill?" It is needless for us to remark that in this country, as in America hitherto, the process above suggested has been exactly reversed, and with by no means encouraging results.

On a kindred subject, that of general technical education, we must confess that America is ahead of us, if not in practice, at all events in arguments. The *New York Times* supplies us with one which throughout our long discussions on technical education we seem to have entirely overlooked. It is an argument against all attempts at teaching handicrafts, by the aid of taxation, which do not include the manifestly impossible task of teaching every handicraft. Why, it is asked, should a man who desires his son to be a shoemaker be compelled to bear the expense, and at the same time pay taxes for having his neighbour's son taught, say, carpentry? Why, indeed? And if carpentry and masonry, why not law and divinity?

The audience at the meeting of the Society of Telegraph Engineers was without doubt greatly interested in Profs. Ayrton and Perry's very beautiful and ingenious modification of the Cardew voltmeter. We thus describe it because we feel that we, in common with all electricians, owe a debt of gratitude to Capt. Cardew for giving us the principle of heat-expansion for voltmeters, and not because we are forgetful of the fact that in this new instrument great originality and true invention are conspicuous. For the measurement of alternating potential differences we have hitherto been dependent almost entirely on the Cardew instrument, for the electrometer is a laboratory rather than a workshop and engine room instrument, and is, further, except in its more delicate forms, only suitable for the measurement of very high potentials. But the Cardew voltmeter is almost useless for anything under 20 volts, and does not always prove a sure guide in the parts of its scale where it is expected to be correct. Our experience of this instrument may have been rather unfortunate, but we must confess that the quality which has most recommended it to us has been its great convenience, rather than its accuracy or freedom from change. And in this respect we fear that the instrument to which Prof. Ayrton introduced us the other evening can scarcely be expected to effect a radical cure, as, being founded on the Cardew principle, it must to some extent share the disadvantages as well as the advantages of its prototype. Nevertheless, it is a very interesting contribution to the series of practical measuring instruments for which we are indebted to the ingenuity and skill of

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Profs. Ayrton and Perry. We have had enough, and more than enough, of instruments which merely enable us to do in another way—and not better—what can already be done by several old and tried appliances. We want improvements, not simple varieties; and, above all, we want reliable and simple instruments for alternating current work.

SOME twelve months ago one of the most ingenious experimenters with whom we have the honour to be acquainted constructed a voltmeter based upon the Cardew principle, and not wholly unlike that of Profs. Ayrton and Perry. This instrument, although minus the advantage of an Ayrton and Perry spring, yet possesses one feature of very great value which is not found in the other types. We are not at liberty for the present to give a detailed description of the instrument, although we hope to be able to do so before long.

CAPT. CARDEW's story of the voltmeter with an 18in. dial is really very funny. This instrument was required for an engine room at Chatham, and was ordered to be of such a size as to be readable at a distance of at least forty feet. But no sooner was the apparatus made than it was discovered that, in the only position where room could be found for it, it was impossible to get more than two feet back from the dial.

BUT this is, probably, not by any means the largest Cardew voltmeter which has been made. Two or three of the London manufacturers possess, or have possessed, such apparatus of Brobdingnagian proportions, but the largest of which we have any knowledge was erected by Mr. Nelson Cherrill, in the Swan lamp factory at Lille. The wires were in this case carried up through several floors of the building. They were, if we recollect rightly, of iron, and quite satisfactory results were obtained.

ALTHOUGH comparatively little of a novel character has of late been heard from the owners of the chief patents connected with storage batteries, we happen to know that they are not suffering for want of attention. Amongst other things, considerable attention has been devoted during the last twelve months to the production of a type of cell especially suited for electric traction. There can be little doubt (*pace* the Bentley-Knight Railway Company) that a very extensive field is being rapidly opened up in this direction. And there can be still less doubt that the requirements of a storage battery to meet this work are of an extremely exigent nature; and further that they have been fully satisfied by no single cell at present in the market. Every impartial observer who is acquainted with the facts of the case will bear us out in this assertion. It is therefore highly satisfactory to learn that the E.P.S. Co. have been quietly devoting considerable time, money and skill to the solution of this pressing problem.

SECONDARY batteries are likely before long to claim attention on other grounds. An important scheme is afoot for supplying some four or five thousand lamps in a certain London district by means of local batteries charged in series from a central station. We might more briefly have characterised the system by the mystic letters B. T. K.; but, although the general principles are the same as those which were (not) carried out at Colchester, it would be invidious and unfair to brand the new experiment with the failure of 1883. Much has been learnt since that date, and we are confident that the new attempt will at least start under fairer auspices, and with every chance of success which matured experience, acquired skill, and improved appliances can give it. We shall hail a successful result with unqualified satisfaction.

THE pamphlet issued by the E.P.S. Co., in which the advent of the venture above referred to is foreshadowed, opens, naturally enough, with a vigorous attack upon all systems of distribution—especially transformer systems—in which entire dependence is placed on moving machinery. There is very little in these elaborate strictures with which, *from an a priori point of view*, we should be inclined to differ. The engineer who undertakes to light a district without any species of reservoir on which to depend in the event of accident to his machines undeniably undertakes a very serious responsibility; but, on the other hand, we confess that it appears to us that the question as to whether or not the engineer is *justified* in undertaking this responsibility is one which can only be settled by an appeal to practical experience. Arguments of a precisely similar character would *a priori* tell with equal force against a railway system; but our railways, which altogether depend upon the continuously reliable performance of manifold and intricate mechanism, do, as a rule, discharge satisfactorily the services expected from them. So with central station lighting, minus storage batteries; the last few years have seen a gradual accumulation of evidence that properly designed engines and dynamos in competent hands can be entrusted to perform their functions with a degree of certainty which may be considered within the limits of the practical requirements of the case. And after all this is not saying very much.

BUT, other things being equal, let us by all means have a storage system. One *other thing* here chiefly to be considered is the price which must be paid for the additional safeguard. In the scheme just alluded to the tariff has been fixed at 8d. per unit. This is by no means a high figure, and we are informed that every precaution has been taken not to underestimate the cost.

So far as London is concerned fogs seem to us to be the great enemies of this system. The scheme provides at present for the installation of two sets of cells at each station, each capable (we presume) at a push of undertaking the whole of the local circuit. The two batteries are each to be charged for a period of eight hours per diem, but the engine power estimated for is only 2 3rds that required for the direct supply of the whole of the lamps. What, then, happens after two days' heavy fog?

OUR esteemed correspondent, Mr. O. C. D. Ross, really does us too much honour. We cannot but feel gratified that in accepting Mr. William Webster jun.'s challenge he expresses a

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desire that the arbitrament should be placed in our hands. We hasten to state that while sincerely anxious to be of service in the matter we had not contemplated, and do not see our way at present to accept, the position of umpire. But this point need offer no difficulty; at least, we think not. As to Mr. Ross's amendments to the terms of the contest, they are so reasonable that we have little doubt that an agreement will be arrived at *nem. con.* We most cordially endorse the suggestion that the emission of noxious fumes should constitute an immediate disqualification. A letter from Mr. Shippey on the same subject has reached us since writing the above.

THE P.B. epidemic has broken out in a severe form in the United States; witness the following extract from a P.B. advertisement (circ. November, 1887) in the *New York Insurance Journal*:—"In this system the electricity is generated and supplied by the batteries composed of essential and ultimate elements which, being in ordinary sized jars, are easily handled and readily portable." . . . "With the exception of this trivial waste (the element being merely nominal in cost), and the constant renewal of the preparation, there is no other expense attached to the maintenance of the plant, as the ultimate elements retain their initial efficiency for many months—possibly years." From this it is at least clear that unessential and approximate elements are not in it, as compared with the "essential and ultimate" variety.

AN energetic provincial contemporary, the *East Anglian Daily Times*, whose offices, as we happen to know, are lit throughout with electric light, has recently devoted considerable space to enforcing the advantages and practicability of central station lighting. Our contemporary's enthusiasm has been not unnaturally aroused by the fact that, with the assistance of Messrs. Paris and Scott, its own electrical plant has been utilised for lighting the Public Hall at Ipswich on the occasion of a *conversazione* of the Ipswich Scientific Society. After remarking that "in this carriage of light along the streets there is no loss of power," our contemporary proceeds to show how, by means of motor-generators, distances far exceeding a quarter of a mile may be covered. The following passage, if not exactly scientific, is extremely eloquent:—"To light houses at Rushmere, for instance, the electricians would carry from the central engine station a small copper cable about the thickness of telegraph wire. The smaller wire gives higher energy, the electricity dashing along it like a stream confined in a rocky channel. On the thick, roomy wire the electric current has space to flow along like a broad and placid river; on the narrow wire it becomes confined and impetuous, and on reaching its destination would smash the delicate lamps, and act generally after the manner of torrents. So the electricians use the vigorous power thus produced as a motive force, turning with it a dynamo, which generates fresh electricity of its own. The thick, shorter wire carries, as it were, direct light, though you cannot see it as it goes along the street. The small long-distance wire conveys power and energy from which light is made. So the electricians are now ready to light workshops and houses at great distances from the central station, and the time seems at hand when by union and organisation men should begin to utilise the power they possess to a far greater extent than has hitherto been done."

THE Brussels Exhibition of 1888, even at this early stage, gives promise of a highly successful issue. The selection of Mr. Lee Bapty as the representative of the British section will go a long way to ensuring the confidence of exhibitors from this side the Channel; while in the electrical and electric lighting sections no better selection could have been made than M. Mourlon as chief superintendent, with M. Bandsept as chief engineer. Both these gentlemen are well known and as highly esteemed in electrical circles in this country, as well as in their own.

Indian Military Telegraphs.—The military telegraph line through the Khyber Pass has now been completed between Jamrood and Lundi Kotal. This brings the wire within 140 miles of Cabul.

Telegraph Appliances.—We have received from Messrs. Spagnoletti and Crookes their illustrated catalogue of apparatus, tools, and materials required for the construction and working of railway telegraph lines.

The Brussels Exhibition.—In the electrical section of this exhibition proposals are invited for laying down a tramway line, the cars to be drawn by electric motors, supplied from accumulators. Both automotor cars and separate engines are to be employed.

Brighton.—At a meeting of the Brighton Town Council, held on November 24th, in moving the adoption of the report for the electric lighting at the Pavilion, Mr. Alderman Abbey stated that a considerable saving, amounting to £340 a year, had been effected by the use of electricity.

Award.—We are pleased to learn that the Woodhouse and Rawson Electric Supply Company (Limited), of Great Britain, acting as agents to the Electric Gas Lighting Company, have received the highest award, namely, a Diploma of Honour, for their exhibition of electric lighting appliances, burglar alarms, &c., at the American Exhibition recently closed.

Ramsgate.—Messrs. Sherrin, Vaughan, Sherrin and Co., who have recently commenced business as electrical engineers at Ramsgate, have completed an installation of some seventy lights at the offices of Messrs. E. G. Westall and Co. Messrs. Sherrin inform us that from orders and inquiries on hand they anticipate a prosperous future for the electric light in the Isle of Thanet.

Manchester: Lecture on Central Station Lighting.—On Saturday last Mr. J. R. Williamson read a paper before the Manchester Association of Engineers, at the Grand Hotel, Aytoun-street, on "Electric Lighting from Central Stations." Mr. Williamson treated the subject with marked ability, and devoted his remarks chiefly to the modern methods of distribution by transformers.

The Royal Yachts.—A Portsmouth telegram states that a proposal to supply the two principal Royal yachts with the electric light has been submitted to Her Majesty, who has given her consent on condition that the new light is not introduced into the state apartments of the "Victoria and Albert." There is no objection to all parts of the "Osborne" being electrically lighted. The estimate as to the cost is to be

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sent to the Admiralty, and it is understood the work will be carried out while the usual winter repairs are in hand.

Manchester.—The Manchester correspondent of the *Engineer* states that Messrs. Richard Hornsby and Sons, of Grantham, have obtained the contract for the whole of the engine and boiler power for the electric lighting, heating, and ventilating of the enormous building which is being erected in Manchester for the purposes of Buffalo Bill's Wild West Show. Besides a large number of smaller lamps, there will be twenty-five large arc lamps; and there will be about 8,000ft. of steam piping for heating. The Brush Company is supplying the electrical plant.

Rheims.—The municipality of Rheims has had before it a proposal from the Société Lelarge-Edison for the electric lighting of a limited central area of that city. The council, considering the smallness of the proposed area and the absence of obligation on the part of the company, has resolved to decline the proposal, while at the same time it holds itself ready to consider the question favourably when an electric company offers to light the whole of the town on terms resembling those under which the Gas Company is at present carrying on its business.

"Wickwar."—The *Trowbridge Chronicle* says:—"The electric light is to be introduced into Wickwar; streets, roads, and public buildings are to be lighted therewith. Mr. H. Wiles will provide all motive power, erection of lamps, &c., at an infinitesimal cost to the inhabitants. Then a committee, who is a guarantee for seven years, will find the funds required for streets and railway station road." We congratulate the village, town, or city of Wickwar (? Is this a printer's error for War-wick) on possessing such enlightened and philanthropic residents as Mr. Wiles and his committee.

The Indian Telegraph Department.—It is said that a despatch from the Secretary of State regarding the block in promotion in the Telegraph Department authorises the Government of India, with a view to facilitating promotion, to offer exceptional pensions to a large number of officers, as an inducement to retire before the time when, under existing rules, they become entitled to pension. The officers chiefly affected by this offer are those who came out in the years 1869, 1870, and 1871. A reorganisation of existing grades in the Department is also believed to have been ordered, and it is hoped that it will afford immediate promotion to several officers.

Dublin.—The Corporation of Dublin will, on or before Friday, the 9th inst., receive tenders for the lighting with electric light of streets in the city of Dublin, in length about 1,950 yards, for a period of seven years, from 1st July, 1888. The parties tendering shall be bound to supply, erect, fix, and maintain all the necessary plant, machinery, engines, boilers, dynamos, conductors, pillars, &c., at their own expense. Water power is available on the property of the Corporation at Island Bridge, about two miles from the streets to be lighted. Specification, form of tender, and ground plan of Island Bridge and streets proposed to be lighted, can be had at the office of Mr. Spencer Harty, C.E., borough surveyor, City Hall, Dublin.

Submarine Arc Lamp.—Messrs. Cox, Robinson and Co., of Liverpool, have brought out a submarine arc lamp specially for divers' use in wells. The body is of Delta metal, hexagon shape, with gland at the top for the cable. The globe is a cylinder of annealed glass, ¾in. thick, 14in. long, and 10in. diameter. This is ground perfectly flat at each end, and then cushioned on thick india rubber pads held between two circular plates by means of vertical metal rods, which also act as guards. The whole is then fastened to the body by means of wing nuts and hermetically sealed by placing india rubber discs between and applying any desired amount of pressure by means of the nuts. This lamp will stand a pressure of 140lb. to the inch.

The "Watt" System.—The *City Press* states that "the "Maxim-Weston Company has already received a large "number of orders for the new 'Watt' system of lighting, "and are in communication with the authorities of the city "and other large centres for the purpose of street lighting. "The company claim that they are now in a position to "obtain six arc lamps of 150 candle-power, in place of one "as heretofore, from one electrical horse-power, and that "they are thus a long way in the van as compared with "their competitors. Mr. Watt, whose untiring energies in "the electric field deserve success, will probably shortly "be in a position to enlighten the darkness of this, the "'Metropolis of the World,' by means of his recent dis-"coveries."

Exeter.—An informal and private meeting, convened by circular, was held recently at the Victoria Hall, Exeter, to discuss the propriety of forming a company for the purpose of supplying the City of Exeter with the electric light. The proceedings were held in the interest of the promoters of the Thomson-Houston system, and there was a fairly numerous attendance, among those present being the Right Worshipful the Mayor. No definite steps were taken, but several gentlemen present offered to take shares should a company be formed. In the meantime Mr. Massingham proposes, with the consent of the authorities in the erection of the wires, to light experimentally a central area of Exeter, the Albert Museum, the Athenæum, and the establishments of several tradesmen. A second meeting to further consider the proposal of forming a company is to be held shortly.

India.—The viceregal palace at Simla is to be supplied with a very extensive installation of electric lights. We understand that the matter has been placed in the hands of Mr. W. H. Massey, of Twyford, Berks.—Our contemporary, *Indian Engineering*, has the following paragraphs:—The electric light has been introduced into the East Indian Railway collieries at Giridhi, and marks the opening of a new era in Indian mining. The miners are said to be delighted with the innovation, and go to their work with greater confidence than before.—The subject of electric tramways is likely to come under the notice of the authorities in India before long. We understand that arrangements have been made in London to supply the city of Madras with a tramway system on the new principle, pending the acceptance of the offer by the authorities on the spot.

Projector Signalling on Clouds.—In our issue of Nov. 18th we described some experiments recently carried out at Newcastle-on-Tyne on the possibility of transmitting signals by projecting a powerful beam of light on the clouds and flashing Morse signals. About the same time a similar experiment was made at Singapore by the officers of two ships of the Royal Navy on the East Indian station. The "Orion" was in port at Singapore, and the "Espoir" left for Hong Kong at a given speed of 10 knots per hour. When she had been gone long enough to have covered 60 knots the "Orion" flashed a message to her by means of the electric light directed against the clouds. It was not known at the time whether the message of four words was understood or not, but the "Espoir" has since reported that it was made out and replied to. It thus appears that the experiment was only partially satisfactory, but even this shows the possibility of flashing signals to distances hitherto undreamed of. The reading of the message, however,

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will always depend upon the condition of the atmosphere, and no message could be read unless the clouds are well defined and low.

Ship Lighting.—The electric lighting plant of the Great Eastern Railway Company's twin screw steamship "Peterboro," which left the Earle's Shipbuilding Company's yard at Hull on Friday, the 25th ult., consists of a compound-wound Phœnix dynamo, driven with rope gearing by one of Messrs. Alex. Shanks and Son's 6 horse-power Caledonian engines. The 100 16 candle-power 50-volt Swan-Edison lamps are arranged in four parallel circuits, and controlled by main switchboard in engine room, each light also having its own combined switch and cut-out. The pendant and bracket fittings are of new and graceful designs, those in the saloon and state rooms being silver-plated, and in the officer's and second class cabins burnished brass. The ship is also provided with gangway lights, consisting of clusters of lamps in enamelled reflectors, with lowering and raising gear for use when embarking passengers at night. The work has been carried out by Mr. Robert Woodley, electrical engineer, of 248, Burdett-road, London, E., who has recently completed similar installations on the new Wilson liners "Colorado" and "Apollo," and also an extensive arc lighting installation at Messrs. Earle's shipbuilding yard and engineering works.

Shotfiring by Electricity in Mines.—On Saturday, 19th Nov., some experiments were made in the Ynishir Colliery (near Cardiff) on the use of electricity for blasting purposes, in the presence of a large number of representatives of the mining industry. The interior of the mine, for some distance from the bottom of the shaft, was illuminated with incandescent lamps. Holes had been bored in the rock at distances apart of about 20 yards. They were then charged with dynamite, and the fuse and electrical connections having been adjusted, the hole was stuffed with clay. All the visitors and workmen then left the pit, and returned to the surface. The current was then switched on from the dynamo room, and the charge exploded. On entering the mine, it was found that all the charges except one had fired, and the result was considered exceedingly satisfactory, the single unexploded charge being due to a break in the connections. This unexploded charge was then fired while the party remained underground. The explosion dislodged a large quantity of material from the roof. After once more reaching the surface, the miners' representatives unanimously passed a resolution cordially congratulating the proprietor and manager of the Standard Colliery, Ynishir, on the results of the experiment.

The Vienna Breakdown.—We have received from a trustworthy correspondent in Vienna the following additional information on the above subject:—"The boilers which caused the recent failure of the Opera House installation were of a type known as Captain Scott's patent, and the arbitrators appointed in Vienna to consider the causes of failure, and at whose door the blame for the breakdown was to be laid, have found defects in the design of the boilers, and also attribute the failure to the water used. As this matter is, however, still *sub judice*, it would be unfair to comment further upon it. The temporary interruption of the lighting itself, however, seems to have been caused by official interference. Considering that four boilers were provided for the opera lighting, and of these three were available for the purpose, there seems no pressing reason why the exchange of the boilers could not have been effected without interrupting the lighting. The Imperial Continental Gas Association have, however, made the best of the matter, and have with the utmost energy, and in a remarkably short time, succeeded in putting up two huge goods locomotive boilers and resumed the lighting of the opera on the 19th Nov. A new battery of boilers has now been ordered of the Babcock and Wilcox Company, of Glasgow, who have undertaken to guarantee their efficient working. As regards the absurd rumours which have obtained currency that the cables proved bad, they are utterly without foundation, as a recent test of the cables showed a much higher insulation resistance than had been specified. Most of the reports from local sources were undoubtedly coloured by the jealousy of those electricians in Vienna who would have liked to have had a hand in the matter, which, in spite of the numerous difficulties encountered —some of which were put in the way—must be admitted to have been carried out, so far, at least, as the electrical details are concerned, in a most praiseworthy manner."

Telephonic Communication at Sea.—Mr. H. F. Boyer, of H.M.S. "Malabar," has recently made a number of experiments in this direction with an apparatus of his own invention. Previous attempts of the same general character by some American electricians were described in our issues of Oct. 7 and Nov. 4. The following description is given of the arrangement:—The source of sound consists of a large gong or flat bell supported against the side of the vessel below the water line. A straight tube leads from this gong to the "bridge" of the ship, and in its interior is a rod fitted with a handle at its upper end, by which the hammer of the gong can be worked, and the gong struck at will. The striking of the gong may, of course, be done in keeping with a code of signals, such as the Morse code used in ordinary telegraphy. In the centre of the gong is fixed a modified Bell telephone with a large and sensitive diaphragm. The telephone is connected by means of wires running up the tube to a second telephone on the bridge within reach of the observer there. This forms the receiving part of the apparatus. If we suppose two ships fitted with this combination, it is only necessary for one to rap out her message by striking the gong and for the other to receive it on her telephone. The sound waves from the transmitting gong traverse the intervening water and vibrate the diaphragm of the submerged telephone at a distance. These vibrations excite currents in the latter, which, in traversing the second or observing telephone, reproduce the original sounds of the gong. Small explosions of gun cotton under water have also been used by Mr. Boyer in place of the gong; and an ounce of gun cotton can in this way give a signal which is distinctly heard a mile off under water. Such signals under the sea are independent of fogs or stormy weather; and they hold out the possibility of lighthouses and lightships being able to signal vessels at all times. Moreover, ships, in addition to signalling each other, could also signal lightships, or announce their number to Lloyd's stations, if the system prove successful. Mr. Boyer's plan, which so far has given encouraging results, is somewhat similar to that of Prof. Lucien J. Blake, of the Rose Polytechnic Institute, United States, which was described in our issue of November 4th. Instead of a submerged telephone, however, it will be remembered that Prof. Blake uses a microphone in circuit with the deck telephone as a receiver. With this arrangement Prof. Blake has been able to transmit subaqueous signals from a locomotive bell through a mile and a-half of the Wabash River comprising three or four windings. Mr. Edison also is reported to have signalled through a mile of the Caloosahatchie River in Florida during the present year. His system has not been fully disclosed, but it appears to be similar to those described. It is to be hoped that this new development of telephony will be pushed as far as possible.

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MOTOR-GENERATORS.

THE PARIS AND SCOTT SYSTEM.

This week we are enabled to reproduce photographs and sectional drawings of the Paris and Scott motor-generator which recently underwent some tests at the Newcastle Exhibition (see *Electrician*, October 28th, 1887).

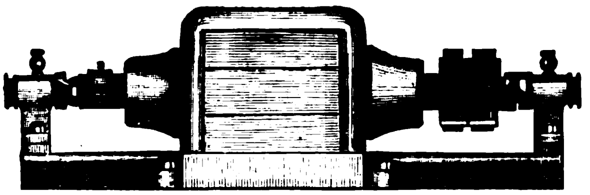

FIG. 1.—Side view.

We have little to add to the description then given, except that the mechanical details of the construction will be perfectly

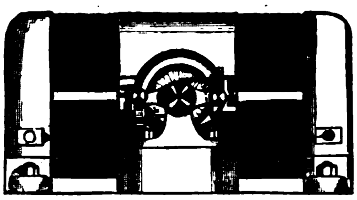

FIG. 2.—End view.

clear from the drawings. Fig. 1 is a side view, Fig. 2 an end view, Fig 3 is a cross section taken through the centre, and

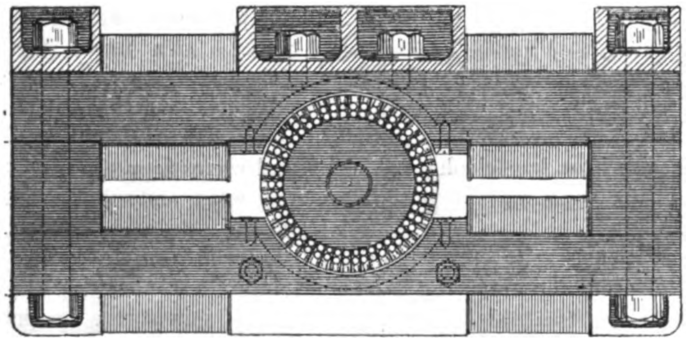

FIG. 3.

Fig. 4 a section at right angles to that of Fig. 3, the two latter being on a somewhat larger scale. In Fig. 4 P P is the primary

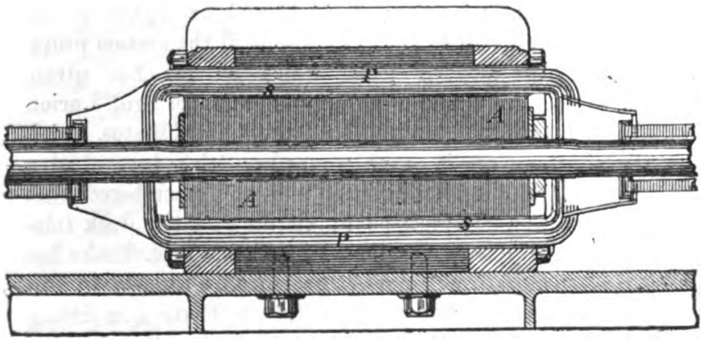

FIG. 4.

coil, S S the secondary, and A A the core, built up of iron discs.

The core of the drum is 12in. long by 5in. diameter, and each commutator has 45 sections, there being two turns per section for the secondary low-tension circuit (right-hand commutator), and eight turns per section for the primary high-tension circuit (left-hand commutator.) The electrical details of the machine were fully discussed in our issue above referred to. The normal speed of this machine is 1,200 revolutions.

Messrs. Paris and Scott, however, inform us that they are "now enabled to make transformers to run at much higher speeds with perfect safety, so that their efficiency and output can be very considerably increased." Perhaps the most satisfactory feature of this design is that the self-induction coefficients of the two armature coils practically neutralise one another, and there is absolutely no lead and practically no sparking on the brushes.

THE JEHL AND RUPP SYSTEM.

The adjoining illustration, which is taken from a photograph in our possession, shows the external appearance of the Jehl

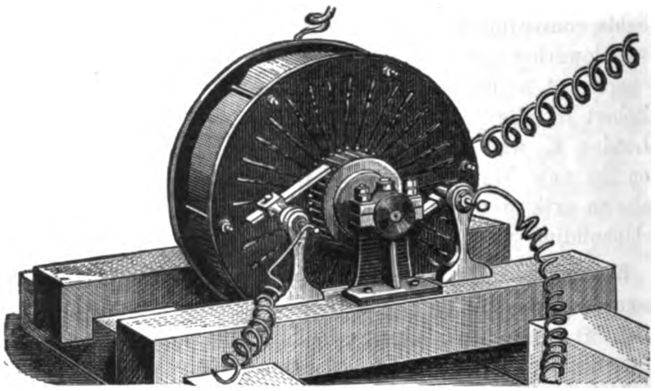

FIG. 1.

and Rupp motor-generator of the double ring type, as described in our articles of October 28th and November 11th. The

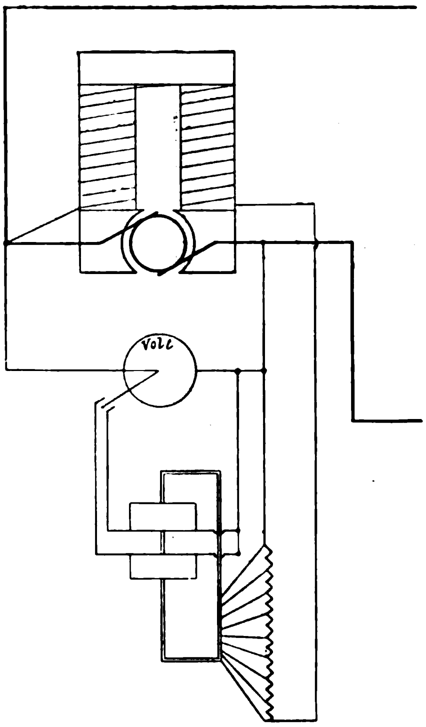

FIG. 2.

primary high-tension commutator is visible, the secondary low-tension commutator and the pulley from which the apparatus is driven are on the other side. Fig. 5 shows the latest type of the "distribution commutator." This apparatus has been much simplified and improved since we first described it. The necessary length has been reduced to one-fourth by the device of cutting each ring into four equal portions, and so making it

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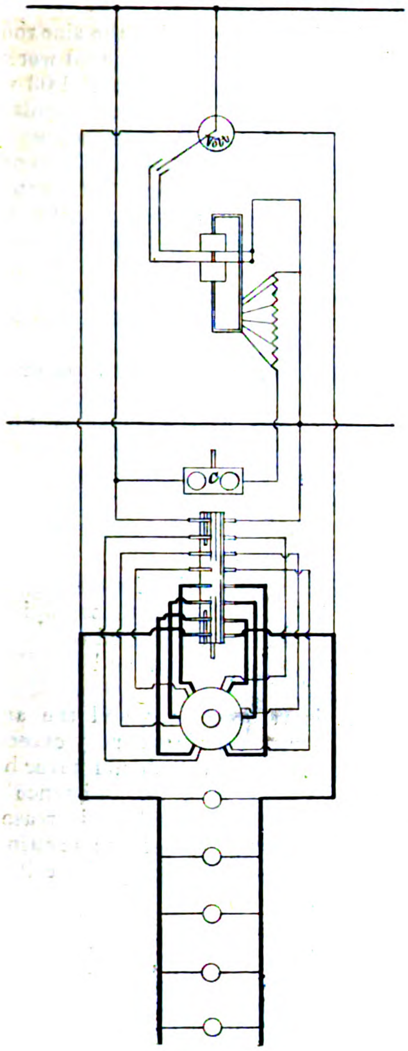

Fig. 3.

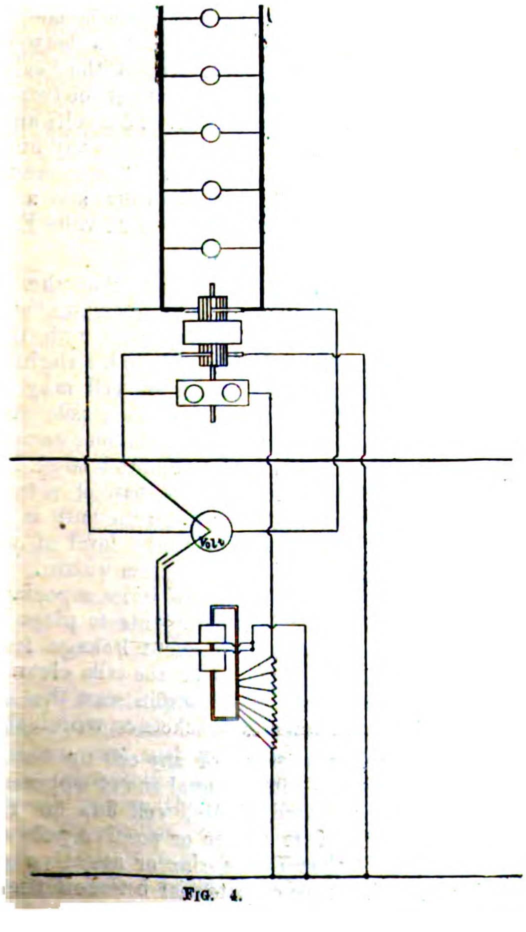

Fig. 4.

serve for four coils instead of one. The ordinary commutator on the left-hand side, which takes the high-tension current of 10 or 12 amperes, will serve to scale the apparatus.

We now conclude our account of the system by giving diagrams of the circuit connections for parallel distribution. Fig. 2 shows the generating dynamo with regulator for constant potential, as described in our last issue. Fig. 3 is a sub-station, provided with a $\frac{1}{4}$ H.-P. motor (*c*) driving a distribution commutator. In this case it is essential that the speed of the motor should be constant, and for this purpose (as the load remains the same) a regulator of the same type is employed. Only one motor-generator of the stationary type is shown connected to the distribution commutator; but it will have been understood already that there might be any number, having their corresponding coils connected in parallel. Fig. 4 shows

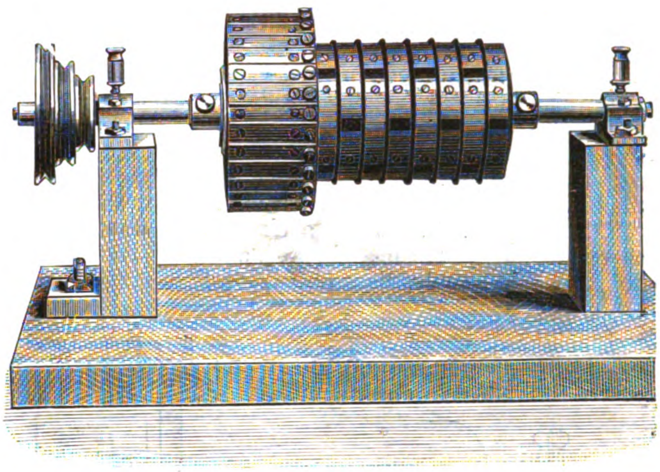

Fig. 5.

the connections for a single motor-generator of the automatic type.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

By A. E. Kennelly, Electrician, Eastern Telegraph Company.

Chapter III.

Batteries.

(Continued from page 53.)

19. Another type of cell in very general use for discontinuous work is the Leclanché. This is a single-fluid cell in

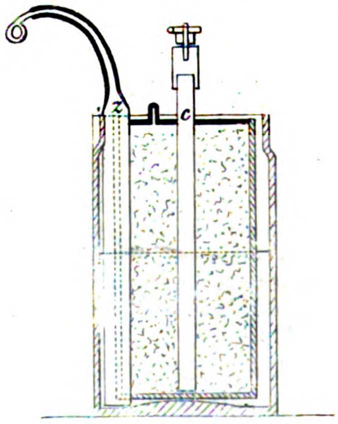

Fig 6.

which zinc is the positive element (*see* para. 8), carbon the negative, and a solution of salammoniac the exciting liquid. The carbon plate is surrounded by crushed carbon in intimate

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admixture with black oxide of manganese, either by being inserted into a porous jar with those materials, or in what is called the agglomerate cell, by having those materials solidly cemented round the carbon plate in a cylindrical form under pressure. The zinc element is generally in the form of a rod, placed in one corner of the cell, which is represented in section at Fig. 6. During the cell's action the salammoniac, which is a compound of ammonia and chlorine, is decomposed, the chlorine attacks the zinc forming zinc chloride, which, being soluble, disappears into the solution, while the ammonia developing at the surface of the carbon also forms a soluble compound with oxygen, which it seizes from the oxide of manganese. Thus, in action, the zinc is consumed, its chloride accumulates in solution, the carbon is unaltered, and the oxide of manganese loses some of its oxygen. Practically, however, when the supply of current from the cell exceeds a certain rate, and consequently when the chemical decomposition reaches a certain degree of activity, the above simple set of reactions is not strictly carried out, secondary and more complex chemical products form, which soon culminate in the development of hydrogen at the surface of the carbon plate, and polarisation (*see* para. 10) sets in, unless resting time is allowed for the secondary products to dissolve. For this reason the Leclanché cell is not suited for strong and continuous current supply, and its E.M.F. (*see* para. 4), normally about 1·48 volts, soon falls under hard work. For more limited, and especially for intermittent current supply, however, the cell has many advantages.

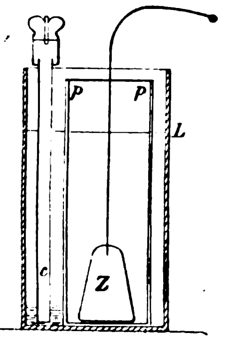

Fig. 7.

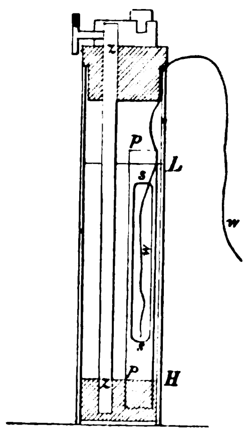

Fig. 8.

Its internal resistance is generally between 2 and 5 ohms, and can be made much lower if with this object the cell be heated. It requires very little supervision, and when engaged on light work, such as the occasional ringing of bells, will not unusually continue to operate for two years without any attention or recharge. If the zinc rods be of good material, there is also exceedingly little local action.

20. Fuller's bichromate cell is another single-fluid form of the zinc-carbon combination. The outer cell is a stoneware jar, as shown in section at Fig. 7. In it stands the carbon plate C, and the porous pot *p p*, filled with water to the level L, and holding the zinc plate Z, which is usually of conical form, and kept permanently amalgamated by dipping into mercury placed for that purpose at the bottom of the porous cell. The solution for the outer jar is of bichromate of potash in water acidulated with one-ninth of its volume of sulphuric acid. During hard work polarisation takes place to some but not as a rule to any serious extent, and the E.M.F. of the cell is approximately 2 volts, and its internal resistance from about 2 to 5 ohms.

21. A very convenient and portable form of cell for testing and light signalling work is De la Rue's single-fluid chloride of silver cell, represented in section at Fig. 8. The outer cell is a glass tube one inch in diameter, with a flat bottom. It contains a solution of 200 grains of salammoniac to the pint of water, and the elements are zinc and silver. The latter is in the form of a wire, *w*, fused into a cylindrical mass of chloride of silver, which is further protected by a paper tube, *p p*, to keep it from coming into contact with the zinc rod, *z z*. If set up with care, and not subjected to very hard work, the E.M.F. of this cell is remarkably constant at about 1·03 volts, and the average is so well maintained by different cells that in the absence of a standard of E.M.F. more accurate, it may be generally relied upon for that purpose to a limit of 1 per cent. when comparing measurements made at different places. Its internal resistance in good order is from 1½ to 5 ohms. The dimensions of the plates prevent the use of these cells for hard work, as the zinc would soon be entirely consumed; but they take up so little space, are so easily insulated, and once carefully set up require so little attention, that they are admirably adapted for testing and signalling, particularly on board ship. As the zinc should never touch the paper tube in the cell, it is a good plan when setting up the latter to first pour in melted paraffin wax to the height (H, Fig. 8) of about half an inch, and then lower the elements into their proper opposite positions, so that they remain fixed at their lower ends as the wax solidifies. It is also well in order to prevent corrosion to whip with silk the external loop of silver wire which connects cell with cell.

22. A cell which is most useful in testing, but which is used almost solely for the purpose of supplying a reliable standard of E.M.F., is the Clark standard cell. This is a combination of pure zinc and mercury, and its E.M.F. is 1·45 volts at 66° F., diminishing very slightly as the temperature rises. This E.M.F. is very constant, and the amount of its variation between different cells is generally exceedingly small. To maintain its constancy this cell should never be allowed to send a strong current. Its internal resistance is therefore immaterial; but as it tends ultimately to increase enormously with age through the drying up of the exciting salts, it is necessary to ascertain when employing the cell that its resistance is not excessive.

23. The usual mode of connecting any number of cells together to unite their powers is by joining the positive pole of one cell to the negative of the next all through the series. The E.M.F. and resistance between the terminal poles of the battery so formed will be the sum of the E.M.F.'s and resistances of the individual cells. Thus, if the zinc pole of a Fuller cell, whose E.M.F. is 2 volts and resistance is 3 ohms, be connected to the carbon pole of a Leclanché, whose E.M.F. is 1·5 volt and resistance is 5 ohms, then between the carbon pole of the Fuller and the zinc pole of the Leclanché respectively—the positive and negative poles of the two-celled battery so formed—there will be an E.M.F. of 3·5 volts and a resistance of 8 ohms. Similar reasoning applies to any number of cells. So that if we connect up *in series*, as it is termed, 20 Daniells, each having an E.M.F. of 1·05 volts and a resistance of 10 ohms, we shall obtain a battery of 21 volts E.M.F. and 200 ohms total internal resistance.

24. It is important to remember that the necessity for improving the insulation of cells increases with the total E.M.F. accumulated, or, in other words, with the number of cells connected in series. For although a slight film of moisture on the outer surface of a glass cell may only allow an inappreciably small current to pass from pole to pole of that cell singly, the loss of current may become serious when that leakage may form the path of escape to a large E.M.F.; in the same way that a small leak at the base of a tank may cause only a trifling escape of water when the tank is nearly empty, but might allow of serious loss as the level of water and consequently the pressure is raised from within. It should be the object, therefore, with large batteries, especially when they are employed in delicate measurements, to place them on insulating supports, and also to prevent leakage from cell to cell by keeping the outer surfaces of the cells clean and dry. A good method is to coat with paraffin wax the outer surfaces of the cells and the trays or brackets on which they stand.

25. As long as the poles of any cell or battery are insulated their potentials will be equal and of opposite signs. For example, if an insulated Daniell cell has an E.M.F. of 1·08 volt, the potential of its copper or positive pole will be 0·54 + or positive, and that of its zinc or negative pole 0·54 – or negative, the difference of potential between them being thus

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1·08, equal by definition to the E.M.F. Similarly with an insulated battery of 100 volts E.M.F., the potential of the positive pole will be + 50, that of the negative pole − 50. Consequently if the battery be homogeneous, the potential at its centre must be zero. This zero potential is really the potential of the earth and of all neighbouring conductors in connection with it. So that like the effect of the moon's gravitation on the ocean, which produces in the tides a fluctuation of level above and below the normal level of the sea, the effect of the contact of the different metals of a cell, either singly, or as accumulated in a battery, is to produce at the insulated poles potentials equally deviating above and below from the potential of the earth, which, being constant, is reckoned as zero. So that when we speak of potential we tacitly refer to this earth potential zero, but no such allusion is necessarily made when we discuss difference of potential, viz., E.M.F.; just in the same way as when we speak of the level of a position as being 3,000ft. high, we refer it to the mean level of the sea, while difference of elevation is an idea in which the sea level may have no part.

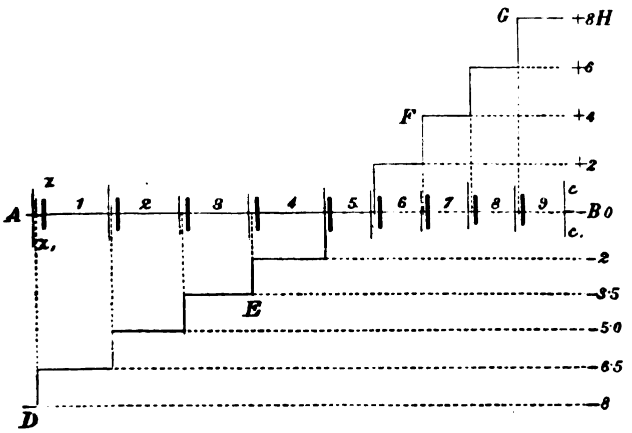

Fig. 9.

26. Fig. 9 shows how we may graphically represent the rise of potential in an insulated battery. The thick lines similar to *z z* across the dotted line A B represent the zinc plates, and the thinner lines similar to *c c* the copper or carbon plates of the battery. Now, holding up the paper so that its plane is vertical, the upright lines similar to A D represent in length and direction the potential in the battery at the points on

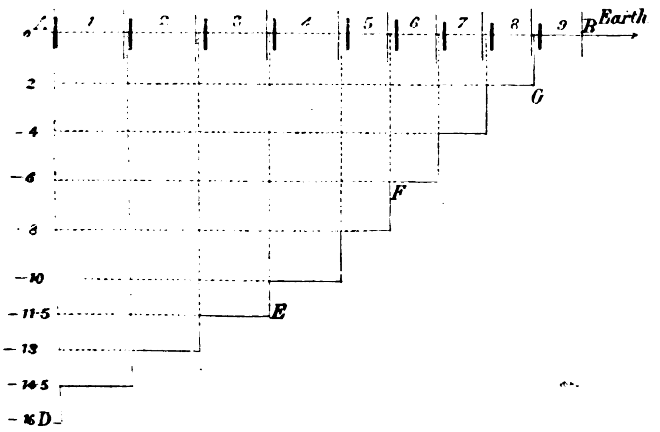

Fig. 10.

which they rest. Positive potentials are represented by lines above A B, negative potentials by lines below. Suppose we take a scale of measures such that a difference of potential of one volt shall be represented by one-eighth of an inch. As we may select any horizontal scale we please, it will be convenient to make it correspond to the internal resistance of the battery, and our diagram will then embody both E.M.F. and resistance. Let us take a horizontal scale along the line A B of 8 ohms to the inch. Now let us consider the case of an insulated battery, A B, of nine cells, numbered as shown, the first four being Leclanché's, each of 1·5 volt E.M.F. and 3 ohms resistance, and the last five Fuller's, each of 2 volts E.M.F. and 2 ohms resistance. Then the total E.M.F. will be 16 volts, and resistance 22 ohms, so that the latter will be represented on our scale of 8 ohms to the inch by placing the poles of the battery $\frac{22}{8} = 2\frac{3}{4}$ inches apart, so that the line A B must be $2\frac{3}{4}''$ long. Each cell may now be marked off along this line, the distance from one connection to the next being $\frac{3}{8}''$ for the Leclanchés and $\frac{1}{4}''$ for the Fullers. The plates may then be sketched in their right positions, as shown. The vertical scale has now to be considered. We have seen in the preceding paragraph that the points A and B will receive equal and opposite potentials, each equal to half the total E.M.F., which in this case is 16 volts; consequently, B being the positive pole will have a potential of + 8, represented on our scale by a point one inch above A B, while the negative pole A will have a potential of − 8, indicated by the point D one

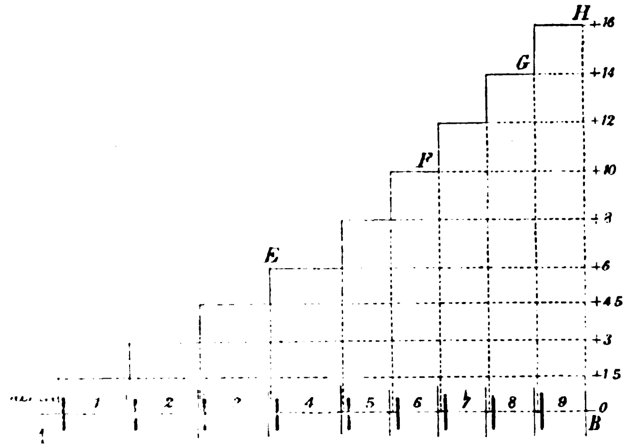

Fig. 11.

inch below A. By then carrying horizontal lines from D and H parallel to A B, and altering the potential opposite each junction of plates by the exact amount of E.M.F. that junction generates to scale, we shall produce the zigzag line D E F G H, every point of which represents by its distance from A B the potential of the point opposite to it in the battery.

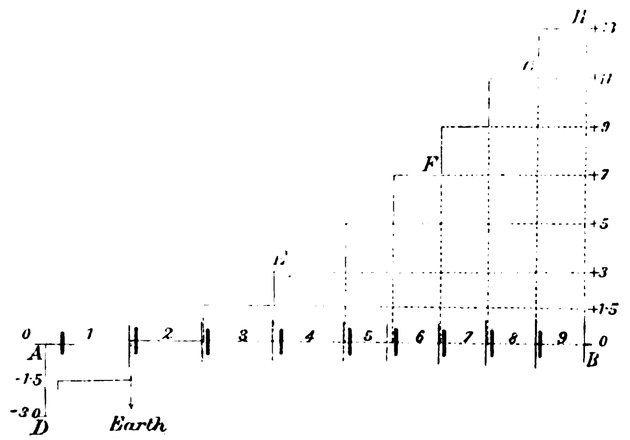

Fig. 12.

27. In the particular case of the battery we have considered, we see from the figure that the potential line in the first Fuller cell, No. 5, coincides with the line A B, and since A B is also, as explained in paragraph 25, the earth potential or zero line, the potential of cell No. 5 must be zero. Consequently, the potential line D E F G H will not be disturbed if this cell be connected with the earth by dipping a wire into it whose other end is deeply buried in the ground, for example; for by so

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doing we simply connect two bodies at the same potential, and no current tends to flow under ordinary circumstances between two bodies at the same potential any more than water tends by gravitation to flow between two points at the same level.

28. If, however, the earth wire be removed from cell No. 5, and connected to any other point in the battery, the position of the line of potentials will undergo alteration. For example, if the earth wire be connected to B, the positive pole, as in Fig. 10, a current will tend to flow from B to earth, but cannot be maintained because it can find no circuit, the battery being otherwise insulated. The point B and the earth cannot, however, retain different potentials after connection, so B's potential falls to zero. But the mere connection of B with earth cannnot alter the E.M.F. of the battery—that is to say, cannot alter the difference of potential existing between the poles A and B; so that as B has lost a potential of 8, A must be augmented by that amount, and will therefore become − 16, as shown, and filling in the sections of the potential line as before, we find that it has descended bodily from its previous position through the distance H B. Similarly, if B be insulated, and A instead earthed, as in Fig. 11, the potential of A becomes zero, that of B makes up for the loss by becoming 16, and all other points retaining their relative potentials to these the potential line is moved bodily up to the position shown. Again, Fig. 12 shows the effect of putting to earth a particular point in the battery otherwise insulated. We thus see that in all cases of connecting to earth, the potential of the point earthed is brought to zero, and the potentials of all the remaining points in the battery follow from this point by the simple summation of the individual E.M.F.'s as they are met with.

REVIEWS.

A Handbook for Steam Users: Being Rules for Engine Drivers and Boiler Attendants, with Notes on Steam Engine and Boiler Management, and Steam Boiler Explosions. By M. Powis Bale, M.I.M.E. (London: Longmans, Green and Co, 1887.)

It is much to be hoped that reservation of all rights in this book will be strictly observed by book makers and paragraph writers, for it is not very likely that any copyist will escape selecting some of the many statements that should be avoided. It is possible that the book may be of use to some amateur engineers who are owners of boilers, for a small amount of education will enable them to check the statements it contains, while the mere mention of some points in connection with boilers and boiler working will be sufficient to prevent their being forgotten—that is to say, the book may act as a mere reminder. For steam users generally it is not, however, of any use, nor can it be to the ordinary run even of the most intelligent boiler or engine attendant, but will rather lead them astray on many points.

It is not advisable to tell an engine attendant that "a little fine-powdered plumbago or asbestos may be added with advantage, especially to the cylinder lubricator;" nor that "where there is a constant surplus of steam for the work to be done, instead of damping down and working at a lower pressure, the author prefers in many cases to keep steam up to the full pressure and to shift the excentric sheave so that the slide valve will cut off earlier and expand the steam to a greater extent." The consequence of following the first of these suggestions, except in the most careful manner possible, will be to fill lubricating channels or grooves in bearings and stop lubrication, and to fill clearance spaces, and do a great deal more harm than good. The second suggestion shows an almost incomprehensible ignorance of the working of steam boilers, and of the effect of moving an excentric. Firstly, a constant surplus of steam does not in the least degree make it possible to work the engine at a lower pressure; secondly, if there is a constant surplus, that may equally be the case of working at a low or at a high pressure; thirdly, it would be much better to maintain the proper pressure and work with a smaller fire; and, fourthly, if an engine attendant shifts the excentric so as to cut off earlier he will also admit steam much earlier, and if the cut-off is to be materially affected the lead will become so excessive as to make the engine work very badly, if at all, and with great loss; fifthly, the average attendant will make a muddle of it if he shifts the excentric at all; and, sixthly, the tendency would, if successful, be to use less instead of more steam.

Again, it is not advisable to tell an attendant who has a troublesome pump that "occasionally a valve that has struck may be released by a few sharp blows of a hammer on the outside of the clack cover." It is of no use to a boiler attendant to tell him, without any explanation, that "in cases of urgency steam may be 'whitewashed' by turning the exhaust or a jet of steam into a base of the chimney-stack." It is useless to tell a traction engine driver that "for travelling he is to get steam up to 75lb. pressure." Engine and boiler may both be made to work at 100lb., and for some travelling the driver may want all this, and it is nonsense to tell him that "when going down a hill the gauge glass should show 4in. of water, when going up about 1in." When "working boilers and engines in frosty weather" the attendant is told, amongst other very wise things, that he should "in very frosty weather have the flywheel of the engine barred or turned round by hand a few times in case of ice being in the cylinder." After writing this it probably occurred to the author that it might not work, so he tells the attendant to "thoroughly warm the cylinder before starting."

He might therefore have saved the attendant the trouble of barring the fly-wheel round before warming the cylinder, unless he thought of crushing the ice so quickly that the thermal equivalent of the work done would sufficiently raise the temperature. In telling the steam user how to find the necessary size of a factory chimney, he misquotes a rule given in "Modern Steam Practice," by Mr. J. G. Winton, and for a chimney 80ft. in height, for a Cornish boiler of 40 nominal horse-power, gives an area in inches of "539, say 26in. diameter, or 23 square inches at the top." This latter will puzzle the boiler user.

Enough has been said, perhaps, to show that this book needs revision or suppression; but we must mention that according to the author's rule for the nominal horse-power of engines, the addition of a condenser to a non-condensing engine of, say, 90 nominal horse-power, reduces its power to about 35 horse-power!

INCANDESCENT LAMPS.—A NOTE ON THE CONDUCTIVITY OF GLASS.

BY NELSON K. CHERRILL.

Prof. Ayrton, in his "Practical Electricity," page 271, says that the resistance of dense flint glass increases very rapidly as the temperature diminishes below 60° C. From this it might perhaps be inferred that the resistance might be expected to diminish as the temperature rose above 60° C.

My attention was first directed to this subject some two or three years ago by noticing a very curious and persistent fault in a number of incandescent lamps under my charge at the time. One of the platinum wires of these lamps was almost invariably blackened where it passed through the glass. For a long time this defect was attributed to careless manipulation on the part of the glass blowers; it was thought they had not taken care to see that the wires were really clean when put into the glass. This possible cause of the failure having been eliminated without affecting the result, I was led to note that the blackened wire was always on the same side relatively to the arrangements for supplying current to the lamps during the pumping process.

This led to the idea that perhaps glass was not, after all, under certain conditions, such a perfect insulator as was usually supposed.

A soft rich lead glass was being used for the manufacture of the bulbs at that time, and I found that—especially after recent working—a very moderate rise in temperature produced such a fall in resistance that a very appreciable amount of current would pass through the glass, the glass between the platinum wires acting as a shunt to the carbon of the lamp during exhaustion. This led to the supposition that the blackening of the wires was caused by a deposition of lead from electrolysis of the glass.

The current used had an E.M.F. of about 100 volts.

I tried the resistances of the glass between two platinum wires,

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sealed in in the ordinary manner, but without any carbon filament, and I found that immediately after sealing in—that is, as soon as the bulb was cold—the resistance did not amount in many cases to more than 15,000 ohms, but the next day it had risen enormously higher.

When, however, the glass was reheated to only a moderate extent—that is to say, far below its melting point—the resistance was very largely decreased, to be again increased on cooling; but, according to my observations, the full or normal resistance is not attained—at any rate, with lead glass—for many hours after the glass is cool. It would seem as if some action of crystallisation goes on in the glass, even after cooling, which changes the molecular arrangement.

Lead glass is not peculiar in exhibiting this property of becoming, to a very appreciable extent, conductive under the influence of moderate heat.

An interesting experiment can be tried with a very small battery and galvanometer by simply fusing a bead of glass upon a wire, and inserting a second wire into the bead, making up the circuit so that the current passes through the glass. I used one cell of Leclanché's battery and an ordinary astatic galvanometer, with a bead of glass about the size of a small pea; the needle of the instrument flew to its stops as soon as the bead, held in the blow-pipe flame, assumed the faintest redness. By manipulating carefully the bead can be drawn out, and the effect on the galvanometer may be noted at the same time; in this manner I got a clear deflection of 10deg. of the scale through a filament of glass three-eighths of an inch long without only three cells of battery. Hard German glass behaves just in the same manner. I have tried many kinds of glass and they all give the same result.

There is one point in connection with this matter which may be worth consideration. Glass is usually looked upon as a *solid* substance, and it is certain that at the temperature at which the electrolytic action I have referred to in the manufacture of lamps took place the glass was far from being in a "plastic" condition; and yet in a solid substance we have here a movement of the constituent molecules into new positions, called, I think, in electrolysis "the migration of ions," the "solidity" of the material being maintained all the time.

ON THE CONDUCTIVITY OF AMALGAMS.*

BY C. L. WEBER.

The author points out that up to the present no complete and concordant results have been obtained on the resistances of a series of amalgams of varying percentages of added metal.

A considerable difficulty in such an investigation is that between the amalgams so poor as to be perfectly fluid and those so rich as to be perfectly solid there lie those of medium richness, which at ordinary temperatures are neither the one nor the other. These do not remain homogeneous when standing, but separate into layers varying in solidity and richness, and when the resistance of such amalgams is measured the result is the mean resistance of these varying layers, and not that of the homogeneous amalgam.

In order to avoid this source of error the author's measurements were made on amalgams at a high temperature, so as to have them perfectly fluid and homogeneous. Preferably the temperature was above the melting point of the added metal, but this was only possible in the case of bismuth and tin. In the case of lead and cadmium the temperature could not be taken high enough with satisfactory results. The tin amalgams were tested at (about) 240deg. C., those of Bi Pb and Cd at (about) 265deg. C. These temperatures were maintained as accurately as possible, and a few degrees too high or too low would have no appreciable effect on the results, as the temperature coefficients of the amalgams were very low. At 265deg. all the alloys of Bi were liquid, and for Pb and Cd all those up to 70 per cent. added metal.

There is no doubt that working in this way far more light should be thrown on the effect of chemical composition *per se* on the resistance than when solid amalgams or alloys are used,† for structure, which has so large an influence on the behaviour of the latter, is completely eliminated. The resistances were measured on a Thomson bridge. The alloy was in a U-tube with enlarged ends, heated in a paraffin bath. The tube was closed with corks, through each of which was passed an iron wire electrode and a glass tube. By alternately blowing and sucking at one of the tubes the amalgam could be thoroughly agitated from time to time, and kept perfectly homogeneous.

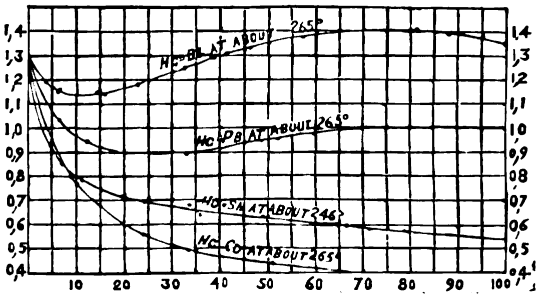
The results obtained are plotted in the curves shown.

Mathiesen, it will be remembered,‡ working with solid amalgams of Pb Cd Sn, &c., made the conductivity of the amalgam equal to the mean conductivities of its components, thus making the curves straight lines. Herr Weber's curves with fluid amalgams are anything but straight. Those for Sn and Cd drop very rapidly for the first small additions of added metal, and then appear to follow a straight line law, falling steadily to the resistances of these metals when pure.

The Bi curve also falls sharply for the first small additions, then passes through a minimum and rises again, passes through a less accentuated but clearly marked maximum, and then falls to the pure metal resistance. This amalgam, it is interesting to note, has at one percentage a *higher* and at another percentage a *lower* specific resistance than either of its components.

In the case of lead, the mininum is equally well marked, and the resistance also falls below that of either component. The amalgams beyond 70 per cent. of lead could not be tried, so that a maximum similar to that obtained for Bi could not be got; but the author thinks that an inspection of the curve as far as it goes leaves no doubt that it would have occurred.*

That the maxima and minima indicate chemical compounds is highly probable. It will be noticed that they point to combinations represented by Hg_9 Bi, Hg Bi_3, and Hg_3 Pb, and probably Hg Pb_3. It is noteworthy that Pb and Bi, which behave alike, are also near



together in atomic weights, viz., 207 and 210. And that Sn and Cd are likewise similar in curve, and atomic weight 212 and 218.

[True; but then Bi and Sn, which are *closest of all* in atomic weight, are the most *un*like in their behaviour.—ED. *E.*]

* De la Rive gives (*Comptes Rendus*, 1863, p. 698) specific resistance of pure melted lead at 358deg. as 1·04; at 265deg. it would be less, and well below the last point on the lead curve.

* Abstracted from *Annalen Phys. and Chem.*

† C. 6. Braun, "Exner's Report," 1885, p. 247.

‡ *Pogg. Ann.* 110 (1860), p. 190.

MEETINGS OF SCIENTIFIC SOCIETIES.

(Week ending Thursday, 8th December.)

TO-NIGHT, Friday, December 2nd.

INSTITUTION OF CIVIL ENGINEERS.

7 p.m. Paper, "On the Classification of Continuous Railway Brakes." By Mr. A. WHARTON METCALFE.

7:30 p.m. Students' Meeting.

SATURDAY, December 3rd.

PHYSICAL SOCIETY (South Kensington, *3 p.m.*).

MONDAY, December 5th.

SOCIETY OF ENGINEERS.

Paper, "On a New Formula for the Flow of Water in Pipes and Open Channels." By Mr. E. C. THRUPP.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture Series.—I. "The Elements of Architectural Design." Second part. By Mr. H. H. Statham.

TUESDAY, December 6th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper, "On the Bessbrook and Newry Tramway." By Dr. E. Hopkinson, M.A., &c.

WEDNESDAY, December 7th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting.

THURSDAY, December 8th.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS (at the Institution of Civil Engineers).

8 p.m. Annual Meeting for reception of Report and Election of Council and Officers. A Paper, "On Safety Fuses for Electric Light Circuits, and on the Fusing Points of various Metals Employed in their Construction," will be read by Mr. ARTHUR C. COCKBURN, F.C.S., Associate.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

*** Particulars of meetings to be held or papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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The Electrician.

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INVENTORS AND PROMOTERS.

Some recent judicial pronouncements on the obligations between promoters of companies and shareholders are likely to have a very wholesome effect on the business relations of these parties. Anything that is calculated to inspire the public with confidence, and the promoter with caution, cannot fail to facilitate the flow of capital into legitimate channels, and to lessen the difficulties of obtaining it for sound investments. Actions for fraudulent misrepresentation in a prospectus of a limited liability company have latterly become quite common, the law on this point being now made pretty clear. But until the other day the question whether misrepresentation, not fraudulent, constituted a ground for rescinding a contract between inventor and promoter was by no means so certain. Mr. Justice KAY, in the Chancery Division, last Thursday, laid it down that in order to constitute a defence to an action for breach of contract it was not necessary to prove fraudulent or intentional misrepresentation in respect to the original contract; it was sufficient if the misrepresentation was real and material, even though quite innocent in its character. The defendant could on such ground get the contract rescinded; and it necessarily followed that the plaintiff could not obtain damages for the non-fulfilment of such contract.

The action which gave rise to this judgment was brought by Messrs. ELMORE, carrying on business as the Electro-Metallurgical Company, against Messrs. TIMMINS and PIRRIE, agents for Messrs. BARRETT and RAWLINGS, who it was alleged had undertaken to bring out a company for working certain electrolytic patent processes invented by Mr. ELMORE, the sum of £15,000 and 25 per cent. on the capital to be paid the inventor. The promoters never started the company, alleging, among other reasons for not doing so, that the statements of Mr. ELMORE with respect to his processes were greatly exaggerated, and that, in fact, the patents were

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worthless. There is no need for us to go into the merits of these allegations on one side or the other. The evidence, which extended over several days and was of the most conflicting kind, although seriously reflecting either on the memory or the veracity of the witnesses, failing to shake the main contention of the defendants, namely, that they had taken up the scheme on specific statements of the inventor with regard to the practical value of his patents, which proved to be inaccurate and misleading. This alone sufficed to destroy the plaintiffs' case, which was dismissed, but without costs, the Judge remarking that he was dissatisfied with the evidence adduced on both sides.

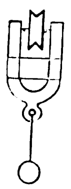
It seems to be plain, therefore, that any false or extravagant representation resulting in misleading one party to a contract, although that may not have been intended, will serve to void the contract in law. In other words, where an invention is concerned, the inventor must tell the truth about it to the proposed purchaser, and must carefully avoid telling an untruth even by accident, or he may find himself utterly unable to enforce the bargain. This is serious news for inventors, whose sanguine and imaginative temperament is always apt to lead them into fits of inexactness, and seldom fails to convince them of the truth of anything they wish themselves to believe. Perhaps we may rely, however, upon their inventiveness to steer them clear of this pitfall in future. The inventor may not be able to sell quite so easily as heretofore; but neither will his competitors; and if the market is limited to the sale of meritorious inventions, the price of the commodity will go up proportionately, and good men and true will get their own. To promoters we need add no word of warning or consolation. They can very well take care of themselves; and perhaps nobody would particularly regret their entire extinction. They have got the best of the inventor in the present action; let them take care that the public never get the better of promoters on a similar plea.

Commenting on this point an evening contemporary which is equally conspicuous—we had almost said equally notorious—for its own lofty morality and its base estimate of other peoples', is very severe on promoters :—"The wily promoter has so long fattened by the sale to companies, promoted for their purchase, of patents whose virtues mainly consist in their vendors' abilities to puff them, that Mr. Justice KAY'S decision will be generally welcomed." We trust it may; but the investing public have only an indirect interest in this action, and if they had been a party to it they would have got nothing by the decision, the parties to the suit being left exactly as they were before the action was commenced. On the other hand, when the public are concerned in a case of this sort they have paid their money and seek to recover it, an object they seldom succeed in accomplishing, whatever the verdict, seeing that the money has generally vanished with the hopes and promises on which it was staked. Possibly, however, the investor may now have a double chance of recovery, both inventor and promoter being clearly liable for misrepresentation. It seems to follow from the judgment in ELMORE *v.* PIRRIE that if a contract can be rescinded before it is completed, it can be rescinded after completion. That is to say, on discovery and proof of misrepresentation, shareholders could repudiate a bargain and claim back their money from the misrepresenting vendors. We should be sorry to say a single word to encourage purchasers to enter upon such a course of action; but it is well that they should know their remedy in future, and still better that inventors and promoters should be made aware of what they may expect if they obtain capital upon representations which are either wilfully or innocently false. The decision will tend to make all the parties more circumspect, more cautious, more accurate, and more conscientious towards each other, and in this way promote a confidence among them which at present is conspicuously absent.

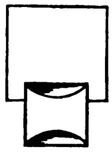
CAPT. CARDEW'S "STANDARD" VOLTMETER.

We are indebted to Captain Cardew for the following description of the "Standard" voltmeter, to which he briefly referred at the meeting of the Society of Telegraph-Engineers and Electricians on Thursday last :—

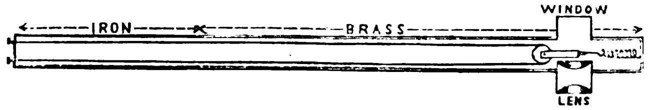
"The instrument consists of a tube made of very thin metal, two-thirds of the length being of brass and one-third of iron. This tube should be 2½in. to 3in. in diameter. About three inches from one end the tube must be cut open at two opposite sides to admit of a lens and a glass window being inserted in short pieces of tube of the proper dimensions, preferably by screwing them in. The lens should be a compound one, similar to the object glass or image-producing lens of a good magic lantern. It is better to use a large lens, and cut off the outside parts with a diaphragm. The lens should, of course, have a very short focal length.



Stirrup with ivory pulleys and cross hairs.



Lamp with converging lens.



Voltmeter Tube, &c.

The end of the tube near the lens is closed with a brass plate, to the centre of which is attached one end of a spiral spring of brass or German silver, formed of an equal number of right-handed and left-handed turns, so that the free end in moving up or down should have no motion of rotation. The other end may be conveniently closed with a piece of ebonite, having two terminals, to the end of the screw of one of which one end of the fine wire is carefully soldered, while the other end is attached to a screw passing through a brass collar screwed in or out by means of a nut and prevented from turning itself. This is connected to the other terminal. The fine wire should be ·0014in. diameter platinum silver. It should be obtained wound on a bobbin of large diameter, and in unwinding the bobbin should be rotated.

"The end of the wire is passed through the brass collar round a little ivory pulley held in a very light aluminium stirrup, and then soldered to the other terminal. The tube should now be held vertically, the ebonite cap put on, and the wire paid away very carefully. There should be a small weight hooked on to a short piece of rather stouter wire attached to the stirrup and carrying a small ring for hooking to. The lens, glass window and brass bottom to tube are all removed. The wire is paid away until the stirrup appears at the bottom, when it is held while the weight is removed and the end of spring hooked in. The brass base is then carefully brought into position, pulling up on the wire all the time and fixed with screws, which should pass through slits in the tube to allow of the brass base being rotated through a slight angle. The wire is now hauled up until the stirrup is above the proper position, when it is soldered and secured to the end of the adjusting screw, and the ebonite cap fixed in position. The cross hairs, which should be the finest spider webs, can now be fixed through the opening for lens, and the final

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adjustments made. Great care is necessary in stringing not to get a twist in the two wires, and to have the plane of the hairs parallel to that of the lens. The lamp should send a powerful parallel beam through the window from a distance of some feet. The screen should be several feet away, depending upon the intensity of light used. In my case I use a whitewashed wall for screen, and have a beam compass fixed at a short distance from it, one pointer of which is illuminated by the beam, and casts a definite shadow on the wall, the point of which is made to coincide with the image of the hair. The hairs are about ¼in. apart, and the magnification is about 100 times. The object of the two hairs, as I explained, is to provide a base line. The images must be kept at a certain distance apart on the screen, then you have the assurance that a certain motion of the image means a certain elongation of the wire.

The chief constants of the instruments are :—Safe potential difference from 12 to 15 volts per foot with ·0014″ Pt. silver wire—thus for 100 volts total length of tube to pulley about 4ft. Cold resistance of wire about 90 ohms per foot. Variation for temperature about ·037 per cent. per 1deg.C. (This has been determined to red heat, but different samples vary slightly.) This has the effect of producing about an equal percentage decrease of reading for increase of external temperature. Elongation about ·04″ per foot, with 12 volts applied.

The tube should of course be placed horizontally to avoid the effect of convection currents, although these are barely perceptible with ·0014″ wire if a maximum of 12 volts per foot be not exceeded.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.

THE DISEASES OF DYNAMOS.*

BY PROF. SILVANUS P. THOMPSON, D.SC.

Considering the wide-spread use of the dynamo-electric machine and the mass of literature concerning it that has sprung up, it seems remarkable that no one should as yet have written upon the topic of the maladies to which such machines are liable, their treatment, cure, and prevention.

Not once nor twice has it occurred in the writer's professional experience to be called into consultation over some hitch that has arisen in the maintenance of an electric light installation where the experience of the engineer and the knowledge of the electrician in charge had failed to discover the cause of the breakdown or suggest an appropriate line of action. Under such circumstances one cannot help comparing oneself to a physician called into consultation over a patient. And as a knowledge of the diseases of dynamos and their treatment form a necessary part of the complete training of the electric engineer an attempt by a specialist to elucidate the subject and systematise it, may appropriately be brought before such a society as this, comprising as it does many electrical engineers.

Moreover, as some of the members of this society have had large and diversified experience in the construction, erection, use, maintenance and repair of dynamos, the writer hails this opportunity of inviting an interchange of expression from all members present respecting the causes that lead to the breakdown of dynamos and their prevention.

The diseases of dynamos, like those of human beings, may be classified under several heads, whether constitutional or acquired, whether curable or incurable, whether surgical or medical in the treatment required.

The constitutional diseases may arise either from defective design or imperfect construction. A ricketty constitution in a dynamo may result either from inherent badness in the forms of those parts which should give strength to the structure, in the employment of bad or faulty materials, or in bad workmanship. Diseases acquired as the result of overwork and of neglect, though classified as acquired rather than constitutional, are more likely to be developed where there is a constitutional weakness. The physician who is called in must have the eye to detect the constitutional taint as well as the more obvious present causes of mischief. When called into consultation upon a human subject the physician's first inquiry is as to the symptoms that present themselves. Perhaps a clinical examination is necessary to learn the whole of the symptoms in the case. The diagnosis of the case being completed a course of treatment suggests itself, which course may be of several kinds. A surgical operation may be necessary, or perhaps bandages and poultices may accomplish all that is required. It may be proper to administer drugs; or in milder cases a change of climate or diet is all that is prescribed. Simple rest accomplishes wonderful cures; but in neglected cases long and careful nursing may be the only hope.

It may safely be said that at least four-fifths of the breakdowns that occur with dynamos—whether partial or total—arise from causes that are more strictly within the province of the engineer than in that of the electrician. On the other hand, many of the mechanical faults that develop themselves in the machine might have been avoided had the engineer possessed a better knowledge of the electric and magnetic conditions that obtain in the running of the machine. It is not often nowadays that armatures fly to pieces. That disaster has seldom occurred since good engineers took in hand the construction of dynamos, though it was, relatively to the number of machines used, a not unfrequent occurrence in the days when armatures were mostly designed by electricians who had little or no knowledge of mechanical engineering. On the other hand, any engineer will make a poor builder of armatures who does not understand the nature of the reactions that occur in the magnetic field—how a conductor carrying a current is subjected in the magnetic field to a mechanical force exerted upon it without any visible means of transmission. If he does not understand this he will not grasp the necessity of so designing and constructing the armature and its spindle that the power applied to the spindle shall be conveyed directly to drive the peripheral conductors. He cannot realise that it is the copper wire and not the iron cores that primarily require to have the power applied to them. He may know that insulation is necessary, and that lamination of iron cores is necessary; but he may for want of full electrical knowledge apply both the insulation and the lamination in an entirely erroneous manner, and produce a dynamo that will break down directly it is put to any severe test.

Amongst the complaints to which armatures are subject are the burning-out of coils, the burning of the binding wire, and the breaking off of the conductors near the ends where they go to join the respective parts of the collector. The burning-out of coils is sometimes due to short-circuiting at the collector between two adjacent sections; but often it arises from short circuiting in the armature itself. In armatures so constructed that the windings of one section lie partly over the top of those of another section this evil is more likely to occur than in those that are not so constructed. Short-circuit between an imperfectly insulated wire and the iron core beneath it is a frequent source of trouble, and this again arises either from bad mechanical work allowing the iron laminæ to become loose, or from the use of unreliable insulating materials. Sometimes armatures are destroyed by charring of the insulation, not in consequence of the overheating of any of the wires, but from the overheating of the iron cores. In such cases either the iron is not properly laminated or else the insulating material between the iron laminæ has failed to insulate. The burning of binding wire clearly arises from want of compliance with the necessary and sufficient electrical conditions. The fracture of the armature conductors near the ends where they turn over to the collector—a most annoying fault when it occurs—appears to be partly mechanical and partly electrical. These conductors are at this point not supported laterally; any engineer would imagine that they were strong enough to stand any longitudinal or centrifugal force to which they might be subjected. Yet they have to withstand severe lateral forces, arising from the fact that they carry strong currents and are situated in a fairly powerful part of the magnetic field, which here extends beyond the edge of the polar surfaces. Hence they are each racked by a lateral force that comes upon them

* Paper read before the Finsbury Technical College Old Students' Association, November 29th, 1887.

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twice in every revolution; and which, moreover, must strain them severely whenever the current is suddenly cut off or turned on. The collector or commutator and its brushes are a fruitful cause of trouble. Brush-holders are rarely as substantial as they should be. The conditions of good mechanical work and good electric work are here somewhat antagonistic; but the mechanical work must be good, otherwise the best observed electrical arrangements will fail. The brushes must not slip or jump with the vibrations of the machinery. If they press too heavily, the surface of the collector will be torn into ruts; if too lightly, the edges of the separate sections of the collector will be bitten and rounded by sparks. The curious disease known as the occurrence of "flats" in the collector has been a source of puzzle and annoyance to many. In many cases the occurrence of a "flat" may be definitely traced to a more or less developed fault in some one section of the armature coil. A broken armature coil, the ends of which still touch against one another within their insulating sheath, may go unsuspected; but it may have the effect—by its increased resistance—in causing an increase of spark at the brush just as it passes through the position of commutation. Hence the corresponding bar of the collector will at every half-revolution be bitten into by a spark a little more than any other bar is bitten into, and so become flattened as compared with the proper peripheral curvature of its fellows. "Flats" do not, however, always arise from this cause. It has been observed that a "flat" may break out on one bar of the collector; and on turning down the surface of the collector so as to remove it, a "flat" breaks out on another bar of the collector. A "flat" may arise from a flaw in the metal of the bar, which passing under the brush, gives rise to a spark that bites away the metal a little further to right and left, and so spreads along the bar until the whole surface of it is more or less bitten away. A little more pressure on the brush, and a better mechanical holding of the brush, are remedies not to be despised. The collector is the one part of the machine most likely to give trouble; it is rarely made large enough; years of experience have not yet given any decisive answer to the question, what materials it should be made of? Whilst English makers are almost agreed upon using either hard drawn copper or else some kind of hard bronze with mica insulation between the bars, Messrs. Siemens and Halske have this year abandoned these for iron bars with air gaps between. Before mica was in general use asbestos was not unfrequently employed, and with curious results. At one time the writer was working with a small Siemens shunt dynamo, giving on open circuit about 80 volts. One day it gave only a little over 70, though the speed was normal. The next day it was under 70, the next it refused to excite itself. The circuits were tested out, as a fault in the shunt, increasing its resistance, was suspected; but there was nothing found wrong. When separately excited from accumulators, it, however, gave only 15 volts on open circuit. In vain the brushes were replaced and the brush-holders cleaned. There was plenty of magnetism, for the armature got hot; yet no sparks, or next to none, at the brushes, even when short-circuited. Suspecting that some of the armature coils were short-circuited, an attempt was made to test the resistances between bar and bar of the collector, but without any very decisive results, owing probably to the roughness of the test. However, there were noticed some slight inequalities, which gave a clue to the cause of trouble. On examination it was found that nearly every one of the collector bars was more or less short-circuited to its neighbour by a charred mass of carbonised oil imbibed into the asbestos which formed the insulation. It was dug out with a penknife and replaced by another material, when the dynamo was restored to its proper activity. This vice has been of not unfrequent occurrence. Only a few weeks after the occurrence named the writer received an urgent call to go to a town in a distant part of England, where a dynamo refused to work. Being unable to leave home that day particular inquiries were addressed by telegraph, and yielded the information that it was a Siemens shunt machine, that all the circuits tested right, but still the machine would not excite itself. Instructions were despatched to dig out the insulation between the collector bars, and the remedy proved effectual. Obviously, in such cases, oil ought not to be used on the collector, but only asbestos dust or French chalk. The writer has subsequently learned that a very similar trouble sometimes arises in certain machines that have collectors so constructed that there is a cylindrical cavity beneath the collector bars into which oil from the lubricators at the bearings may drain, and in which a charred mass ultimately forms short circuiting the entire collector. Another cause of trouble is the small metallic dust which flies from the collector when the brushes press so heavily as to produce ruts, entailing consequences partly mechanical and partly electrical that may end in a breakdown.

Amongst other faults of armatures that give trouble there is a purely mechanical one, arising from want of knowledge on the part of the electrical designer, namely, that of not being properly balanced. Every engineer worthy the name knows that a thing so balanced as to stand in any position is not necessarily balanced for running; that a four-pound weight at three inches from the axis of rotation, though balanced statically by a one-pound weight at twelve inches from the axis, is not balanced by it dynamically, for the moments of inertia about this axis are not equal. On the contrary, a four-pound weight at five inches is balanced dynamically by a one-pound weight at ten inches from the axis. A machine that violates dynamical principles can never be satisfactory. Short bearings where long ones would be appropriate; a high-speed machine where a low-speed machine is the only suitable sort (for example, on ship-board); inside bearings where outside ones ought to be used, and *vice versâ*—all these things have been and may still be answerable for breakdowns. So much the more reason is there for the electrical engineer to be engineer first and electrician afterwards. Not that electrical knowledge is to be despised. The writer once heard an experienced engineer who had been put in charge of a dynamo which was lighting some arc lamps, and doing its work badly, declare that the trouble arose, not from an insufficient supply of current—he did not dispute the quantity of the current—but from the current being of a rather poor quality. There were, in point of fact, too many lamps in the circuit. Again, it is a fact furnishing food for reflection that in those electroplating shops in London where dynamos are used the practical men in charge almost invariably hold the firm opinion that they are not getting the proper current unless they can see sparks at the commutator. They therefore so adjust the brushes that they get a good blaze. Sparking at the commutator or collector is a symptom of disease in a dynamo, just as truly as an outbreak of pustules is a symptom of disease in the human subject.

In the field-magnets vices of construction are more frequent than acquired defects. Field-magnet coils are sometimes wound on frames that are loose, or the coils are badly insulated. When the frames are loose the resulting vibration not unfrequently causes the ends of the wires to snap off short. If there is a single short circuit between coils and ironwork in the field-magnet, then a single short-circuit at any other point—armature coils, collector bars, brushes, brush-holders, or terminals—may work dire disaster. A little Brush machine lent to the Finsbury Technical College by the Anglo-American Brush Corporation had its commutator segments completely ruined in a few minutes by a curious double fault of this kind, which defied detection for several days. There were two short-circuits, neither of which in itself would have have done any harm whatever; but the iron support that held the rocker for one pair of brushes was so fixed by screws as to make a cross connection that short-circuited two pairs out of the four pairs of coils on the armature. A short-circuit between coil and iron core of the field-magnet is more likely to arise in shunt machines or compound machines than in series-wound ones, owing to the much higher electromotive force of the self-induced extra current if the shunt-circuit is from any cause opened. Alternate current dynamos are liable to develop different kinds of faults from those to which direct-current machines are liable. They sometimes exhibit a curious pulsation of a determined slow period in their currents. The cause for this is probably purely mechanical. Again, machines for constant current are liable to disorders of a different nature from those of machines intended for constant potential work. The latter are

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more liable to overheat; the former are more troublesome in respect of sparking, because of the very great variations in the position of the neutral point.

Very little attention seems to have been paid to the question of the goodness or badness of insulating materials for resisting being broken down under working conditions entailed by damp, dust, and oil. Under such conditions it does not in the least follow that the material showing the highest insulation tests is the best. Very few dynamos will show, even when new, an insulation-resistance between iron work and copper work amounting to anything like one megohm. Yet a dynamo that showed only ten thousand ohms of insulation-resistance and mechanically resisted being broken down, would be preferable to one the insulation-resistance of which was a hundred megohms, if that high resistance were secured by employing brittle materials or materials that were destroyed by the presence of oil. Whether mica is in all cases preferable to asbestos, Willesden paper to vulcanised fibre, or shellac varnish to a solution of india rubber, or what other insulating materials should be prescribed in preference, can only be ascertained by a careful study of the failures that have from time to time arisen when one or other was employed.

Only by the study of the malady as it arises can the proper treatment be discovered to prevent its recurrence. In short, by the proper study of dynamo-pathology, we may arrive at a fuller knowledge of dynamo-therapeutics.

DISCUSSION.

Mr. JONES, referring to pulsation on alternate current circuits, said that in one case in London, where two such machines were used, he had traced a very troublesome pulsation to the collector, which had worn oval. The fault was removed by turning up the collector.

Mr. ESSON was of opinion that engineering faults were generally the cause of breakdowns. Speaking of the relative merits of armatures in which the wire was supported by metal projections, and of those where the wire was held on merely by friction, he stated that he had never seen a fault from the wires being attached in the latter manner. The breaking of wires leading to the commutator was more common in motors than in generators. He thought it was due to the spindles bending. For commutators he recommended gunmetal, where great pressure was required to prevent vibration, as in motors on tramcars; in other cases hard-drawn copper, lubricated with vaseline. He thought that unequal sparking of brushes was due to the field being made unequal by the presence of masses of iron about one of the poles.

Mr. MORDEY thought the fault of the breaking of wires near the commutator was an obscure one; it had never been quite satisfactorily explained. He recalled a paper published some five years ago by Hefner von Alteneck, in which the fault was discussed, but left unexplained. Prof. Thompson's suggestion was a good one, but he thought that the first effect of the movement of the wires in the fringe of the field should be to give them all an inclination in one direction. This did not occur, and he thought, therefore, that Prof. Thompson's suggested explanation was not quite satisfactory; neither did Mr. Esson's quite fit in with many cases where the fault had been observed—that was in the steady running of dynamos. The fault had never occurred in Brush or Victoria dynamos. The pulsation in alternating current dynamos was often noticeable. In one large installation in London, where the dynamos were driven direct, the pulsation was very marked, and appeared to be too quick to correspond with the speed of the engine, and too slow to be due to the actual alternations. Referring to commutators he said that various lubricants had been recommended. Sir Wm. Thomson was credited with advancing the claims of treacle for this purpose. He thought that the lubricator was the least important matter in successful collection; nor was it very important how the brushes should be made provided they were not too thick. Carbon had been recommended for brushes, but he thought carbon should be reserved for the arc lamps. The unequal sparking and heating of brushes had often been noticed, and he was inclined to attribute it to an effect similar to that which occurred in arcs, where one electrode got hotter and burnt away faster than the other. He asked others to try, by reversing the polarity of the magnets, whether they could confirm or disprove him. The difficulty was that sparking in modern dynamos was usually very slight, and convincing results were difficult to obtain. The effect of any inequality of the distribution of the fields would be removed by reversing the polarity of the magnets. After describing some simple methods for localising faults in low-resistance armatures—matters in which ordinary bridge and other measurements were of no use—he referred to the question of insulating materials, on which Prof. S. P. Thompson had made some observations. Vulcanised fibre was a very unsatisfactory insulator. The material itself was probably good, but he thought the manufacture could not be carefully conducted, as the substance frequently broke down in a way which seemed to indicate that metal filings or other foreign substances were rolled into the sheets. While acknowledging that dynamos were liable to suffer from many diseases, he thought they should not be too harshly blamed, and mentioned a case where of two similar machines one was always found to require a higher speed of the engine and apparently to absorb more power than the other. He traced the loss to a friction clutch which had been allowed to become covered with oil, and was slipping and absorbing about 18 horse-power.

Mr. D. PEARCE said that he had found the insulation of some Siemens dynamos was very low, the paint used having quite soddened the cotton with oil. He mentioned a case of unequal heating of brushes, where the positive brush always wore several times as fast as the negative. The fields had been reversed, but without effect.

Mr. SUMPNER said that in taking the curve of a Ferranti dynamo he had found that there was an occasional departure from the sine curve, caused by an inequality of the winding.

To this Mr. MORDEY objected that as all the armature coils were in series, all the curves must be alike, any inequality affecting the curve similarly at every alternation.

Prof. THOMPSON remarked that an inequality in the armature winding and another in the field would account for the discrepancy, which would then occur once in every revolution.

After some remarks from Mr. HOWARD SWAN, Mr. DICKSON, and other members, and from Mr. PETTIGREW, who occupied the chair,

Prof. THOMPSON replied. He said that the thickness of brushes should be such that the current should have time to die out of the coil under the brush, to start again, and to come up to the strength of the main current before the coil was again thrown into the circuit. He did not quite give up his idea that the breaking of wires was due to the magnetic field. The sudden putting on of the current in motors would account for the increased occurrence of the fault in them. In motors the brushes might be wider than in generators. Alteneck had told him that the fault had been entirely got rid of by connecting the segments to coils 90 degrees removed from them. He thought, and had previously pointed out, that unequal fields were often a cause of sparking, and that on this account double magnets had an advantage.

A cordial vote of thanks to Prof. Thompson for his interesting and instructive paper terminated the proceedings.

ON THE ACTION OF AN ELECTRIC CURRENT IN HASTENING THE FORMATION OF LAGGING COMPOUNDS.*

BY DR. J. H. GLADSTONE, F.R.S.

When two salts in solution, MR and M'R', are mixed together they partially decompose one another, the proportions of the four resulting salts MR, MR', M'R, M'R', depending upon their relative masses and relative affinities. When one of these salts is insoluble it separates as an amorphous or crystalline precipitate, and the redistribution goes on until the largest possible quantity of it is formed and precipitated. This reciprocal decomposition generally takes place very rapidly, but in some cases it proceeds slowly enough to be watched and measured. While investigating this subject a good many years ago, I made some experiments on the physical forces that accelerate or retard this action, and among them I tried the influence of a voltaic current passing through the mixture. I used a small Grove battery with narrow platinum poles.

1. The first experiment was made with a mixture of tartaric acid and nitrate of potassium. The strength of the tartaric acid was 4·5 grammes, and of the nitrate of potassium 1·02 gramme to 1,000 grain measures (*i.e.*, 64·8 cubic centimetres) of water; and the proportions used were three equivalents of the acid to one of the salt. In a comparative experiment four minutes elapsed before crystals began to appear on making the current, the pole from which oxygen gas was being slowly evolved became immediately coated with potassic bitartrate, and crystals formed throughout the liquid between the poles.

2. A similar result was obtained with potassic oxalate and magnesic sulphate.

3. A mixture of single equivalents of magnesic sulphate and oxalate of ammonium was divided into two portions. Through the one a weak current was passed, and after a few minutes a cloudiness appeared, extending in lines from the one pole to the other, and not below the poles. As yet there was no cloudiness whatever in the comparative experiment.

4. A similar result was obtained with a mixture of calcic sulphate and strontium nitrate, but the lines of cloud extending from the oxygen towards the hydrogen pole were still more remarkable. The comparative mixture was quite clear.

* Read at the British Association, Manchester, as part of the Report of the Electrolysis Committee.

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5. A mixture of citrate of iron and meconic acid goes on increasing in redness for some time, but in this case all the compounds are soluble in water. No acceleration seemed to result from the passage of the galvanic current.

6. A mixture of citrate of iron and ferrocyanide of potassium shows a gradual formation of the blue ferrocyanide. This was hastened by the galvanic current ; but there is this objection to the experiment, that the ferrocyanide itself was somewhat decomposed.

Last autumn a neighbour of mine, Mr. J. Enright, wrote to me to the following purpose :—"Thinking one day some few months ago over the decompositions and recompositions which we figure to ourselves as going on in an electrolytic salt, it occurred to me that we might get some confirmation, or the reverse, of them from passing a current through a mixture of dilute sulphuric acid and a salt of strontium. It is well known that a precipitate does not come down for some time, and that such time is shortened by heating." He then describes an experiment that is practically the same as my own, for which he used five Bunsen cells, and a similar experiment with a potassium salt and tartaric acid, and in both instances he obtained an acceleration, as I did. He adds, however, a somewhat different experiment. Cyanide of potassium was added to a solution of a nickel salt, and the first precipitate was redissolved in excess. Then hypochlorite of sodium was added. On boiling such a mixture, or allowing it to stand for some time, a black precipitate appears; but the moment the electrodes were inserted in a portion of the mixture, although cold, a black cloud was formed.

More recently Mr. Enright, at my suggestion, tried the effect of varying the strength of current. Using a mixture of strontium chloride and sulphuric acid, which would give a turbidity in about seven minutes without the current, he found that when exposed to the influence of seven cells the turbidity appeared in four minutes, of six cells about the same, of five or four cells in four minutes and a-half, of three cells in six minutes, while two cells did not produce any acceleration that could be distinctly recognised.

These experiments seem in accordance with what might be expected if the electrolytic action takes place through the interchange of the radicles of the dissolved salts.

THE DIFFERENT VARIETIES OF THUNDERSTORMS, AND A SCHEME FOR THEIR SYSTEMATIC OBSERVATION *

BY THE HON. R. ABERCROMBY.

The author shows that there are at least three distinct types of thunderstorm in Great Britain. The first, or squall thunderstorms, are simply squalls associated with thunder and lightning, which fly nearly with the surface of the wind. These form on the sides of primary cyclones. The second, or secondary thunderstorms, are associated with secondary cyclones. These move against the surface of the wind, and are very rarely accompanied by squalls. Very little is known of the nature of these squalls, though they are the commonest type of thunder in Great Britain. The third, or line thunderstorms, are apparently of a totally different nature. They take the form of long narrow bands of rain and thunder, perhaps 100 miles long and only 5 or 10 broad. They cross the country rapidly nearly broadside on. These are usually preceded by a very violent squall. The squall which capsized the "Eurydice" was of this type. The air in thunderstorms seems to circulate round a long horizontal axis which would lie in the direction of the thunderstorm instead of round a short and nearly vertical axis, as in cyclones. The outline is given of a proposed scheme for the systematic observation of thunderstorms in England, by which it is hoped that the mechanical nature of the circulation of the air in every kind of thunderstorm may be discovered. It is also shown that if that particular kind of thunderstorm which is not associated with any distortion of isobaric lines can be worked out, a kind of rain could then be successfully forecast which is now very rarely announced. Forecasters now have to depend almost exclusively on synoptic charts of isobaric lines. To this extent they fail ; but it is hoped that observations in the form and motion of clouds may be found to indicate the approach of rain when the barometer shows nothing.

* Abstract of a Paper read before the British Association Meeting at Manchester, September, 1887.

REPORT OF THE BRITISH ASSOCIATION COMMITTEE ON ELECTRICAL STANDARDS.

The committee was appointed for the purpose of constructing and issuing practical standards for use in electrical measurements. The committee report that the work of testing resistance coils has been continued at the Cavendish Laboratory, and a table of the values found for ten various coils is given.

Legal Ohms.

No. of Coil.	Resistance in legal ohms.	Temperature.
Elliott 183, C.C.L. 173	·99938	16°3
Elliott 184, C.C.L. 174	·99924	16°3
L Clark and Muirhead 251, C C.L. 175.	10·0040	17°
Elliott 117, C.C.L. 63	·99976	15°9
Elliott 185, C.C.L. 176	·99962	15°8
Elliott 186, C.C.L. 177	·99959	15°8

B.A. Units.

No. of Coil.	Resistance in B.A.U.	Temperature.
Elliott 41, C.C.L. 55	1·00286	16°2
Elliott 56, C.C.L. 56	1·00039	16°
University Coll. coil, C.C.L. 63	·99983	16°2
Taylor's coil, C.C.L. 68	·99985	18°25
Taylor's coil, C.C.L. 69	10·00209	18°1
Price coil, C.C.L. 66	1·00289	19°2
Price coil, C.C.L. 67	1001·39	19°4
Warden 292, C.C.L. 70	9·99416	16°5

Of these, the coils Elliott, Nos. 41, 56 and 117, have been tested before, but owing to the green colouration mentioned in the last report, showing itself in the paraffin, the paraffin was removed and the coils refilled with ozokerit, which can be obtained more nearly free from traces of acid. This change in all cases produced an appreciable increase in resistance, amounting in the case of Elliott 41 to about ·0025. The coils C.C.L. 63, 68 and 69, are three of the original B.A. units. C.C.L. 70 is a coil sent over from the Johns-Hopkins University for the purpose of connecting their value of the B.A. unit with that found at the Cavendish Laboratory. Shortly after the Birmingham meeting of the Association the secretary received a letter from the Board of Trade, enclosing a copy of the general bases of a convention proposed by the French Government for the consideration of the Powers with the object of carrying out the resolution of the Paris Conference with regard to electrical standards. The convention stipulates that a legal character is to be given to (1) the legal ohm, (2) the ampere, (3) the volt, (4) the coulomb, (5) the microfarad. These questions had been considered by the committee at the Birmingham meeting, and the following series of resolutions, which the secretary was instructed to forward to the British Government, had been agreed to on the motion of Sir W. Thomson, seconded by Prof. W. G. Adams : (1) To adopt for a term of ten years the legal ohm of the Paris Congress as a legalised standard sufficiently near to the absolute ohm for commercial purposes ; (2) that at the end of the ten years period the legal ohm should be defined to a closer approximation to the absolute ohm ; (3) that the resolutions of the Paris Congress with respect to the ampere, the volt, the coulomb, and the farad be adopted ; (4) that the resistance standards belonging to the Committee of the British Association on Electrical Standards now deposited at the Cavendish Laboratory at Cambridge be accepted as the English legal standards, conformable to the adopted definition of the Paris Congress. In reply, therefore, to the letter of the Board of Trade, the secretary sent a copy of the above resolutions with a statement of some reasons which had led to their adoption. During the year the original stan-

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dards of the Association have again been compared by the secretary. An account of this comparison and of the very complete one made in the years 1879-81 by Dr. Fleming, the details of which have not been published previously, is given in appendix. The general result of the comparison is to show that there is no evidence that any of the original coils have changed in value since the year 1876, when they were compared by Prof. Chrystal and Mr. Samuda.

The results of this comparison showed that with the exception of the coil G (No. 43 in Mr. Hockin's report) no change had taken place in the relative value of the coils since Mr. Hockin's comparison in 1867. The coil G has certainly not changed since 1876, and it seems probable, for reasons given in the appendix, that the difference between its values of 1867 and 1876 was apparaent, and not real. Thus, with the possible exception of this coil G of platinum silver wire, the relative values of the seven coils remain as they were twenty years ago.

At the last meeting of the committee it was resolved, on the motion of Mr. W. H. Preece, seconded by Sir William Thomson, to recommend the adoption of the watt as the unit of power. The watt is defined to be the work done per second by the ampere passing between two points between which the difference of potential is one volt. The committee were also of opinion that it is highly desirable to proceed with the construction of an air condenser as a standard of capacity, and for this purpose they desired to be reappointed with the addition of the name of Mr. Thomas Gray, and a grant of £100.

THE "WOOD" AMMETER AND VOLTMETER.

An ammeter and voltmeter based upon the principle of the repulsion of similar poles is not an entirely novel device. It has been employed, for instance, for several years by Mr. Arthur Wright; but considering the advantages which are obtained it is remarkable that more extensive use has not been made of the idea. These advantages are chiefly the absence of permanent magnets, and the comparative ease with which the deflections of the pointer can be made strictly proportionate throughout the scale. This is done by an empirical adjustment of the shape and position of the pole-pieces, between which the repulsion takes place. Of course the instruments labour under the inevitable defect of all soft iron apparatus that the past magnetic history of the iron affects the subsequent readings.

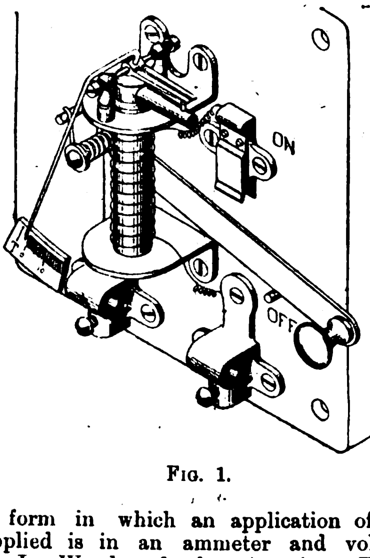

Fig. 1.

The latest form in which an application of this principle has been applied is in an ammeter and voltmeter designed by Mr. J. J. Wood, of the American Electrical Manufacturing Company. The details of these instruments seems to have been very carefully worked out. The diagram (Fig. 1) shows one construction of a voltmeter, Fig. 2 showing the principal part in detail. As will be seen it consists of a core of soft iron, around which a coil of high resistance is wound. This core has a projection, N N, which is given a north polarity by the current, as shown. Pivoted above the core, and in line with the projecting arm, is a soft iron armature carrying a pointer which passes over a scale. Now, it will be seen, according to the well-known law, that the part of the armature immediately over the core of the electro-magnet will have a south polarity, S', induced in it, and correspondingly a north polarity, N', at its outer end. The consequence is that upon the passage of a current through the coil the inner ends N S' will tend to attract each ether, but are kept stationary by the pivoted armature. But the outer ends N and N', being of the same polarity and one of them being free to move, they repel each other, and the end N' is repelled to a distance corresponding to the strength of current in the coils, *i.e.*, the potential at its terminals. The pointer being rigidly fixed to the swinging armature, it indicates the deflection on the scale.

With pure, soft iron and working below the limit of saturation of the iron core, the magnetic capacity of the latter not only remains constant, but its strength ought to be almost in exact proportion to the inducing current. And it is a remarkable peculiarity of the instrument that the deflections on the scale are practically equidistant over the entire range. When the pointer is at the farthest end of the scale the armature S' N' stands almost vertical.

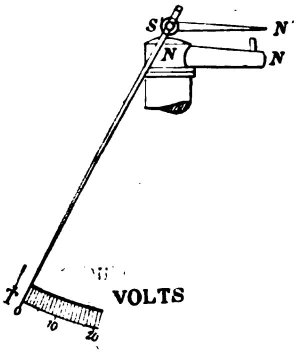

Fig. 2.

It will be noticed that the balancing force employed in opposition to the magnetic repulsion is gravity, no springs being employed.

When the instrument is set up, the pointer is carried over towards the left until the outer end of the armature S' N' strikes the projecting arm of the electro-magnet, and then while these two are in contact the pointer is bent until it comes opposite the mark T (test). The armature is then released, and, swinging upward a short distance out of contact with the projecting arm, it brings the pointer opposite the zero mark on the scale. This method of testing is provided so that if, during transportation or otherwise, the pointer should become bent, it can be readily corrected so as to give accurate readings.

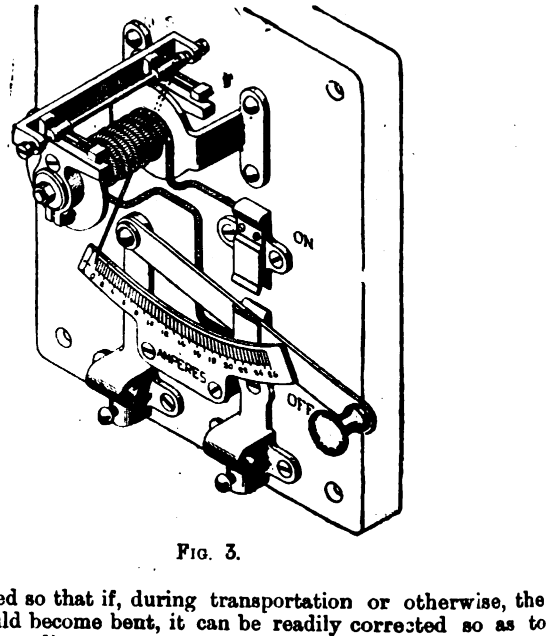

Fig. 3.

Another form of instrument embodying the same principle, and shown as an ammeter, is illustrated in Fig. 3. Here, it will be noticed, both poles of the electro-magnet are brought into play, and act upon two armatures fixed to the same spindle. The action is, of course, the same as that of the instrument just described. In this form, it may also be noticed, the core of the electro-magnet is built up of Norway iron wire, thoroughly annealed, the ends carrying soft iron pole-pieces, which act upon the armatures.

These instruments have been in use for some time in America, and are, as we are informed, doing excellent duty.

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CORRESPONDENCE.

THE FIRE OFFICE RULES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 14th October it is announced that the question of fire office regulations as to electric lighting has been settled by the adoption of the Phœnix rules; but as I think it will be found upon inquiry that the committee of fire offices and the Society of Electricians, to whom the subject was referred, have not yet come to any decision thereon, perhaps you can throw some further light upon the matter.

In the various discussions which have taken place upon the precautions necessary against fire in electric light installations, it is rather disappointing to find that no credit is given to the New York board of fire underwriters for their rules of January, 1882, October, 1884, and February, 1885, which have been of such assistance in framing the present rules upon the subject. The earliest English rules are dated February, 1882, and are almost literally a copy of part of the American rules.

It is much to be hoped that when the new rules do appear, they will be as simple and concise as possible, and that there will be no variations allowable at the will of the fire office inspectors, as that practically makes the rules so much waste paper.—Yours, &c., WM. RAWLINS.

London, 29th November, 1887.

[We print this letter with some reluctance, as we are strongly of opinion that the reopening of the question is very much to be deprecated, and is only calculated to do mischief. Our own columns have shown that the feeling of the leading firms is overwhelmingly in favour of the existing rules. It does not seem to be sufficiently realised in some quarters that any unnecessary tampering with questions of fire insurance can only be injurious to the trade.—ED. *E.*]

THE "COWLES" PROCESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your issue of the 4th ult. a remarkable article on the Cowles aluminium process. As an old experimenter in these processes I might perhaps show that the Cowles Brothers are somewhat sanguine as to the finality of their so-called process. But for the time being I only wish of you, in favour of truth, to allow me to say that the process in question is patented by me under the date of 22nd November, 1883, as an improvement on Benzer's patent of 1858. It may be that one of Cowles' agents having bought from me a patent of 1882 they believe they own my process; but this is not the case, and I am since last year operating quietly in England preparatory to placing my process before the public.—Yours, &c., C. A. FAURE.

206, East Ninth-street, New York, 14th November, 1887.

WELDING BY ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your impression for last week I notice some extracts from Prof. Rühlmann's report (a copy of which I have with me) on Benardos' method of welding metals by means of electricity. I am sorry I cannot agree with him in all he says about the quality of work produced by the inventor.

I went this summer to St. Petersburg for the purpose of examining and reporting on the invention in question, and spent some little time in carefully noting down what I saw of the process. The specimens of welding M. Benardos showed me as having been made by his process certainly seemed to me to be all that could be desired as far as external appearances went, but pieces of metal which were welded together in my sight, and which afterwards I had cut into sections, were in a very unsatisfactory state at the join. In specimens which I brought home with me the metal was brittle, and burnt where it had been under the action of the arc.

Hearing that the invention had been taken up in Paris, I went there to see what was being done, and although I could not have my own pieces of metal operated upon owing to a breakdown of the machinery, I brought away some specimens, which were, however, no better in quality than those I brought from St. Petersburg. In my opinion the use of the arc is to be condemned, as, I think, from what I have seen, it is impossible to escape burning the metals (in the cases of steel and iron) in a more or less degree.—Yours, &c., E. J. RYVES.

Nov. 28th, 1887.

THE TRAINING OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your valuable article (November 25th) on the "Training of Electrical Engineers" will probably lead to a correspondence in your columns from which much good may result. As a contribution thereto, may I trouble you with the following remarks, the preface to which must be a word of thanks for your kindly recognition of the efforts of the professors and teachers of the colleges and similar training schools.

Speaking now as one who has for many years been concerned with the teaching of mechanics and physics, but speaking also as one who for 14 years was the manufacturing partner in a business employing 300 workpeople, I desire to bear emphatic testimony to the fact that you have struck at the root of the whole matter when you say, "For a purely scientific vocation the college training is, of course, an indispensable beginning; but what we are dealing with is a matter more nearly related to pure business than to pure science."

As the head of a technical school which is endeavouring to meet the needs of the profession, may I briefly point out the nature of our chief difficulties, since they, in great measure, confirm your own views? As regards the theoretical training, the most important is the almost utter impossibility of making the average student and his friends see the necessity of learning the elements of practical and theoretical mechanics and *a fortiori* mathematics as essential preliminaries to his training. During the past year the course of instruction here has been considerably extended in this direction, an alteration which has met with much internal opposition, although the fact has been repeatedly pointed out that the managers of the school attached sufficient importance to it to spend £600 thereon to enable the practical part to be thoroughly taught. The conditions attached to the granting of our Vellum Certificate of "passing in mechanical and steam engineering" are regarded as severe and unnecessary, and are a greater cause of failure and delay than any other.

It is, however, in the case of the advanced class, when for half the day I endeavour to make the conditions under which the students work as nearly as possible like those which would obtain in a manufactory, that the greatest practical difficulties arise. The instructor in charge (who here corresponds to the shop foreman, the students representing the workmen) gives out certain work, or allots certain duties, to each student. In cases that occur far too frequently, however, these duties are neglected as soon as the foreman's back is turned, or the student fails to do the allotted work at the appointed time. As a practical instance of this, we frequently have the whole morning's work delayed, if not spoiled, because the students in charge of the engine and boiler do not come early enough to get up steam by ten o'clock. A manufacturer has his remedy for this in the immediate discharge of such workmen, but a manufacturer whose pupils pay him a premium cannot discharge them. It is obvious that this state of things arises from the complete failure of students to realise their responsibilities to themselves, their friends, their instructors, and their future employers, as well as from their want of real interest in their work, and of perseverance in the face of difficulties.

These, Sir, are some of the difficulties which beset those who endeavour to train young electrical engineers. That they have not been altogether unsuccessfully met will be admitted, I think, by many who have had *certificated* students from here. May I be permitted to cite one instance? A well-known firm took into their employ several months ago (after long repeated requests on my part) a student who was "the best of his year" here. After he had been with his employers a very few weeks, they *voluntarily* wrote to me to say that "We did not think he could possibly have learnt as much as he has

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at your school," and added that they had no doubt of putting him on their permanent staff. I know that he has received a salary for the whole time that he has been in their employ, and I also know that when he came to me he had received nothing more than an ordinary grammar school education, but that he had a "turn" for mechanics.

In conclusion, may I be permitted to add that I am at all times glad to receive visits or letters from manufacturers on the subject of education for electrical engineers, and wish that I had more such communications from them ?—Yours, &c.,

WM. LANT CARPENTER,
Manager of the School of Electrical Engineering.
12, Princes-street, Hanover-square, London,
November 29th, 1887.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am very pleased to see that you have taken this very important matter up in your leader columns. I think it would be difficult to overrate the gravity of the question of the training of those upon whom depends the proper carrying out of electrical work. I also agree with you that a college training, or a technical school training, is of very little use for practical work. Young fellows spend a year or two years at a technical school, and having carried all the honours that are open to them, imagine that they are fully qualified to take appointments as salaried engineers; whereas they have only been preparing to learn the real work they will have to perform. In their year or two or three of study, as the case may be, they have only played at practice, and they have probably only acquired as much real knowledge of electrical engineering as they would have acquired in a workshop in a few months.

There is only one method of acquiring practical experience, and that is in practice; and without practical experience an engineer is worse than useless—he is a minus quantity so far as the work is concerned.

On the other hand, I do not believe in boys being placed in the workshop too young. Eighteen years of age is quite early enough, and the three years between fifteen and eighteen can be advantageously employed in acquiring a knowledge of mathematics and modern languages, of which they may never have another opportunity, as in electrical engineering it requires a man's whole time and abilities, once he becomes a breadwinner, to keep pace with the times.

It is wrong also to expose a boy much under eighteen to the influences of the workshop. At eighteen he has more ballast on board, and can stand it better. My own experience in training young fellows has been as follows:—

In the most successful cases they have come to us at about eighteen, having received a good education both physically and mentally. In most cases they have known absolutely nothing of electrical work before coming to us. They have been at once placed in the workshop, and taught to see and to assist with their own hands in everything that is going on. For instance, they will themselves make batteries and bells, wind armatures and field-magnets, and assist in construction work generally. When installation work is on they go out and assist in fixing, starting, or repairing apparatus where necessary; and they are encouraged to ask the reason for everything they see done. I find that it takes months for a young fellow, coming fresh to the work, to settle down to practical workshop details; it is so strange to him, so different from school or college life. During that time, however, he is, in the majority of cases, acquiring the very knowledge the schools are aiming at imparting in their two or three years' course; but with this difference, that he has it more firmly impressed on his mind, from the fact that he sees the whole actual process, and knows the reason for each step of it. After six months the wonderful fascination which the study and practice of electricity exercises over most minds asserts itself, and he is ready to go anywhere and do anything. In twelve months he has generally begun to be useful to go after faults, take details for estimates, perform experiments, take tests, &c. In two years he is capable of efficiently taking charge of an installation, supported, of course, from behind; but he is made to thrash out his own difficulties, guided where necessary for the sake of the business. And in three years, so far, we have always been glad to take him on at a salary. As far as I can make out, if we had taken on any of the students from the technical schools to do the work which our own pupils do we should have been obliged to train them from the very beginning.

I should say that any body—such as the proposed Association of Electrical Engineers—who will grant some form of certificate of qualification, after assuring themselves that the applicant fulfilled the necessary requirements, will confer a boon upon every one concerned. There have been too many cases of men gravitating into electrical engineering, not because they had a genuine liking for it and were ready to go through the necessary training to become qualified, but because they thought it was easy and well paid; and it is to these men and to the theoretical men who come principally from the schools that most of the failures are due.

Any association or any system that will check this will do splendid service to the cause we all have at heart.—Yours, &c.,

SYDNEY F. WALKER.

195, Severn-road, Cardiff, November 29, 1887.

TYPE-WRITING TELEGRAPHS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last week's issue an electrical type writer of American invention, which can also be used as a telegraph, is mentioned.

Will you permit me to point out that such an apparatus has been in existence in this country and used by the Exchange Telegraph Company for some years past, my first patent being dated November, 1880.

I enclose a specimen of the work done by this apparatus, which may be effected at any distance from the operator and upon any width of paper. The printing is not inferior to that of most ordinary type writers, and the instrument is smaller than most of them. No clockwork is employed, and the message is received automatically.—Yours, &c.,

F. HIGGINS.

The Exchange Telegraph Co., 17 & 18, Cornhill, London,
28th Nov., 1887.

[The specimen enclosed by our correspondent is printed on ordinary paper *(not on tape)* and would be taken for the work of any ordinary mechanical type writer.—ED. *E.*]

TRADE DISCOUNTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Sydney F. Walker in his criticism on Mr. Money-Kent's "Note on Trade Discounts" first takes upon himself, on behalf of practical men, to censure the use of mathematical calculation in business matters—which is a rather bold thing to do and savouring of "Podsnappery"—and then, having settled that point, he has the kindness to extract for the "benefit of your readers" the arithmetical statement made by Mr. Money-Kent, and to advance the same as a rule of his own to which his former strictures are inapplicable.

If the calm audacity with which the algebraic result is *borrowed* for the purpose of proving the futility of the algebraic operation were not so laughable, Mr. Money-Kent would justly feel that insult was here added to injury; as it is, however, I should imagine there can be no sting in Mr. Walker's innocent remarks.

I may say that my experience has been identical with Mr. Money-Kent's as to the fumbling methods usually adopted in the office for solving such questions as he deals with, and two or three years ago I had occasion to resolve the formula $\lambda = \frac{100\mu}{100-\mu}$ which he gives, for my own use.

I think that, perhaps, a less elegant working would have been equally efficacious, and I remember that I only used the most rudimentary algebra for my purposes when dealing with the same point.—Yours, &c.,

GUY C. FRICKER.

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PRIMARY BATTERIES: AN ENCOURAGING EXPERIENCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is with great diffidence that I venture to write to you again on the subject of primary batteries, and in doing so can only, for the benefit of the public, give my practical experience of them. Mr. Preece, who is a very great authority on electrical matters, says he is assured that "to utilise batteries for the lighting of mansions and smaller houses must end in disastrous failure." Doubtless he is acquainted with primary battery installations which have ended in disastrous failure, or he would not speak so positively. He deprecates the way in which batteries of all kinds are "puffed" as nauseating, and says that the depolarising agent is made a mystery of, and he evidently does not think that primary batteries will make a stir in house lighting.

Though not an electrician, I have had the honour to be acquainted and to work with those who have introduced primary batteries for lighting purposes to the notice of the public, and I am well assured that primary batteries, properly made and of a simple character, will light both mansions and smaller houses. I dislike speaking of myself, but I can say that part of my house has been lighted by a primary battery since August, 1884, and that no hitch of any appreciable kind has ever appeared so as to disgust me with primary batteries. I put the battery and the installation up myself with the aid of an intelligent man who works my steam engine, and this same man keeps the cells in order and attends to the lighting. My conservatory and a portion of the church are also lighted by primary battery.

The outside cells are of stoneware, and the manipulation of the battery is done without the aid of machinery, *i.e.*, by hand. This takes a certain time, and is reckoned in the cost of the lighting.

I use for my workshop small cells which illuminate a three-light chandelier. Nine of these cells were put under a severe trial by an electrician and chemist, with the result that they ran 3 15-volt 5 candle-power Edison-Swan lamps for 30 hours, the light at the commencement being exactly equal to 18½ candles, which sunk gradually to 12. The battery was then stopped, and a 10 candle lamp of low resistance worked for several hours more. The cost of working a 10-candle lamp, including the loss of zinc, was found to be 1⅕d. per hour, and less with larger cells. The size of the plates in the above battery—that is, of surface exposed—was, carbon 5½ × 6, and zinc 6 × 6.

The cost of the light competes fairly with candles, but is much higher than gas.

Every day sees some improvement in the cost of primary batteries, and more people are learning to know the difference between a toy and a battery which really is of practical use. There is no mystery about my depolariser, which is chromic acid, and there are no fumes. Possibly another day the utilisation of the "bye products" may cease to be a dream; at present I use the spent liquid as a disinfectant and deodoriser.—Yours, &c., CHARLES PENRUDDOCKE.

Nov. 30th, 1887.

PRIMARY BATTERIES FOR HOUSE-LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent, Mr. Thompson, appears by his comments on my letter to have misapprehended its purport, which was to answer a definite fallacy frequently repeated by objectors to primary batteries; and he may possibly not have been present at the meeting at which Mr. Perry Nursey's paper on "Primary Batteries" was read and discussed, for Mr. Nursey guardedly introduced his subject by pointing out that "*as regards small installations* the steam-driven dynamo-electric system still leaves a very wide and remunerative field open for a cheap and efficient primary battery;" while, in the discussion which ensued, one of the speakers questioned whether any battery consuming zinc could be used as a source of electricity excepting for purposes in which expense is not a matter of moment, and hazarded the assertion that "at a cost considerably under one halfpenny we could by the agency of the steam engine obtain one horse-power hour," which I impugned as a misleading statement, so far as it affects the comparison between steam engines and Mr. Nursey's ideal "cheap and efficient battery" for house-lighting purposes and small installations.

In taking exception to my observation that 2d. is not the whole of the daily cost of one electrical horse-power obtained from a steam engine and dynamo, since "the wages of one mechanic would alone amount in small installations to more than the whole cost involved in the use of a primary battery," Mr. Thompson puts the dots on my i's and crosses my t's. He writes: "Let us see how it works out for a user of, say, sixty-two lamps of 60 watts each," and proceeds to show that the wages of one engine-driver earning 30s. a week, divided over the work of an engine supplying five electrical horse-power, would make the additional charge to which I specifically referred 2d. per horse-power hour, or 4s. 2d. per diem, for this one man; but what would be a small installation for an engine and dynamo would not be called small if applied to a primary battery.

There are many houses in London which would be amply supplied with electricity without requiring more than one horse-power, or sufficient to light simultaneously 24 lamps of 10 candle-power, which in most cases would allow of double that number being distributed in different rooms, where they need not all be lighted at once. The charge for the same engine man, if applied to one electrical horse-power instead of to five, would be five times that 2d., or 10d. per horse-power per hour, and if to a ½ horse-power double that, or 1s. 8d., and so on, which exactly corroborates the statement in my letter.

Moreover, the installation of an engine and dynamo supplying five electrical horse-power is very costly, which acts as a deterrent with many individual consumers, and finally, such an engine could not be used at all where in London a primary battery is most often wanted, namely, in the cellar, or some other out-of-the-way corner of a house.

It is plain, therefore, that pending the general introduction of central stations thousands of householders who would gladly adopt incandescent electric lamps on sanitary and decorative or other grounds will be debarred from doing so if indiscriminate opposition to all primary batteries by the leaders of scientific opinion should become to be regarded as the only "good form." Mr. Preece's remark that "those gentlemen who were striving to introduce primary batteries for domestic lighting had an almost herculean task in hand" is only too true, for in such a matter the public is necessarily guided by the men of light and leading; but, in my opinion, none should be more desirous than the great electric lighting companies to encourage the gradual introduction by such means of a general taste for the beauty and hygienic superiority of incandescent lighting. Just as macadamised roads succeeded rough tracks, and in their turn were in due time superseded by railways, so also would it be with the electric light, and, with the experience of the last four or five years to illuminate our judgment, I venture to prophesy that without some such preparation of public opinion and taste the youngest man amongst us will hardly live to see the merits of central stations with dynamos and steam engines fully and universally appreciated. Electricity in its practical applications is still in its infancy, and we are about where the travelling public was in regard to roads a hundred years ago.—Yours, &c.,

Relf-road, East Dulwich. O. C. D. ROSS, M.I.C.E.

P.S.—If Mr. Thompson will take the trouble to re-read my letter he will see that I estimated the consumption of zinc, not at one but at two pounds per electrical horse-power per hour.

THE SCHANSCHEIFF PRIMARY BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. W. H. Preece's report on the Schanschieff battery, no mention is made by him as to the cost of the fluid to the users of this battery. He states that he has been testing and examining the battery for several months, and that a very accurate series of measurements were made with a battery

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which produced one candle-power light for eight hours at a cost of materials consumed of 1d., and we are further told that the residue of this battery can be sold in the market or sent back to the Schanschieff Company, who will recuperate it and take in exchange in part payment for additional solution.

Now, Sir, this sounds very well to the uninitiated, but what we require to know is :—

Firstly. What is the cost of the Schanschieff fluid per gallon ?

Secondly. What quantity of fluid is wanted to run, say, a 5 candle-power lamp for eight hours consecutively, or intermittently?

Thirdly. What amount will the manufacturers allow for the spent fluid when returned to them ?

Fourthly. Who defrays the cost of carriage to and from the manufacturers ?

Fifthly. Where can the residue be sold in the market, who are the likely buyers, and at what price per gallon ?

Perhaps those gentlemen mostly interested in the Schanschieff battery will answer these questions, as they seem to me to be of more importance than the question whether the battery consumes an ounce or two of zinc more or less.

The transport of fluid from the consumer to the manufacturer and *vice versâ* must of necessity be a heavy item, and should be added to the cost of the light. One gallon of fluid by the various parcels deliveries in London, at from 6d. to 8d., and from London to the country from 8d. to 1s. 6d. the gallon, according to the distance. It would cost either the consumer or the manufacturer from 1s. to 3s. per gallon for carriage for the double journey, and more if it were sent over 400 miles.

In the interest of primary battery inventors, I should like to know what Mr. Preece has to say to this.—Yours, &c.,

Denmark-hill, S.E., Nov. 29th, 1887. W. E. Moser.

PRIMARY BATTERIES.—Mr. WEBSTER'S CHALLENGE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : Mr. Wm. Webster, jun., challenges any primary battery inventor or maker to compete with the Holmes-Burke battery, in which he is interested, on conditions which are too restricted to be a practical test of superiority. First, because the competitor is to construct a battery with cells precisely similar in size and number to those he employs, thus excluding, amongst others, all users of round cells ; and, secondly, because the competition would exclude the consideration of at least two all-important points in domestic lighting, namely, the generation of more or less noxious, or inodorous fumes, and the "creeping" which is believed to be inseparable from all batteries using salts, but which hardly becomes seriously noxious until after a rather longer period than 14 days.

I am prepared to accept a challenge with respect to the comparative efficacy of the batteries if these and any other indispensable considerations are included, and am willing, with your consent, if Mr. Webster will do the same, to place a battery in your hands and under your control forthwith (five minutes will suffice to teach your office boy how to manage mine), if you will undertake to determine their comparative correspondence to what were enumerated as the "leading conditions which a primary battery for home-lighting purposes should fulfil" in the paper recently read by Mr. Perry Nursey before the Society of Engineers, Mr. Webster being only restricted to a battery of equal bulk and of a similar number of cells to mine.

I exact no forfeit from him in the event of your decision being, as I anticipate, against him ; but in order to facilitate the examination of the several points omitted in Mr. Webster's conditions, I must limit the size of the batteries to such as you can conveniently place on a table in your office, and would suggest for your convenience that if either of the two batteries should be declared by you to be in any way obnoxious or unpleasant it shall be at once removed, you being accepted as the arbitrator, and your decision as to their comparative merits final.—Yours, &c., O. C. D. Ross.

P.S.—Reporting on the working of my battery after a prolonged examination, Dr. John Hopkinson, F.R.S.—whose authority will hardly be questioned—pronounced that "the liquids used in the cells are less expensive than in any battery having any pretence to constancy." But I readily recognise that the solution of nitrate of soda used in the Holmes-Burke battery (which I have not the slightest wish to disparage) may be almost, if not quite, equally inexpensive.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : I have always believed in the old maxim that "Charity begins at home," and I therefore confess that I should be much pleased to be able to secure Mr. Webster's £25, and thus enable me to give my *employés* a little Christmas treat, the same being derived from a public primary battery competition. So, if Mr. Webster will consent to send 12 guineas to the Editor of the *Electrician* and 12 guineas to the Editor of the *Electrical Review*, with instructions for those gentlemen to hand over 15 guineas of the amount in case his battery is knocked out of time, I will then accept his challenge on behalf of a battery I will produce.

As Mr. Webster's conditions are somewhat vague, I would suggest that the articles and conditions of competition be as follows, the tests to be made with a battery, say, of one or any number of cells up to sixteen, containing 2 gallons of solution in each cell.

I mention 16 cells as the maximum because it is a useful number of cells to feed ten 10 candle-power lamps of 15 volts, coupled two in series according to resistance, or half the number of 30-volt.

Lighting Test.

(1). One or two cells to run a single 2 or 4 volt lamp of 1 or 2 candle-power, with elements kept in solution, and not touched under any conditions until cells are fully exhausted and light out, when zincs should be reweighed and cost noted.

(2). Four cells for running a single 8-volt lamp of 5 candle-power, under precisely similar conditions.

(3). Sixteen cells for feeding the greatest number of lamps the battery is capable of sustaining for runs of six hours per day until exhausted and lamps out. To commence at 12 o'clock, close at 6 daily.

For Power Purposes.

(4). A 2 or 3 cell complete battery and electric motor for driving a sewing machine of any known type until battery is fully exhausted, speed of machines to be taken alternately every half hour.

General Conditions.

(5). The batteries for each installation, Nos. 1, 2, 3, and 4, to be enclosed in sealed cases with the seal of each party, and testing room to be locked up during intervals.

(6). Each party to be allowed one assistant to be present during hours of competition, to watch and take notes.

(7). A test room to be rented for the purpose in the City, for competition, within easy distance of the arbitrators' offices, who shall be at liberty to go into the testing room at all times they may think fit during competition; but no other person to be allowed to enter the room except the competitors, their assistants, and arbitrators.

(8). The rent of testing room and other expenses to be equally divided by competitors.

(9). Some electrician to be appointed by the two arbitrators, whose business it shall be to take the half-hourly readings, speed, &c., of machines running on behalf of the arbitrators.

(10). Lamps to be used to be either "Shippey's" compound metaloid filament, or Swan carbon filament, at Mr. Webster's option ; but in each case the lamps supplied for the test shall be sent to the arbitrators with voltage duly marked thereon, and all lamps shall be put into a box, and each competitor to select a lamp from general assortment until the quantity of same are equally divided.

(11). The arbitrators to decide on testing appliances to be used, and also be allowed to add any other conditions they may think necessary.

(12). Each party to be bound by the arbitrators' decision, which shall be final.—Yours, &c., Arthur Shippey.

13 and 14, King-street, Cheapside, London, E.C.,
30th November, 1887.

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SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

At the ordinary fortnightly meeting of this Society, held at the Institute of Civil Engineers, on Thursday, the 25th inst., the PRESIDENT (Sir Charles Bright) in the chair, a paper was read on "Some Instruments for the Measurement of Electromotive Force and Electrical Power," by Dr. J. A. FLEMING and Mr. C. H. GIMINGHAM. This was followed by a paper on "Portable Voltmeters for Measuring Alternating Potential Differences," by Profs. W. E. AYRTON, F.R.S., and JOHN PERRY, F.R.S.

[Owing to the numerous drawings with which these papers were illustrated, we are unable to reproduce them in the present issue. The following brief account of the instruments is sufficient to give a general idea of their construction.]

The voltmeters of Dr. Fleming and Mr. Gimingham are based upon the electro-dynamometer principle, and they are therefore available for alternating currents. The chief feature of these instruments consists in the employment of a pair of solenoids arranged parallel to one another, and so wound that they exhibit the same polarity at each end, with a consequent pole at the middle. Each of these solenoids is encircled at the centre by a narrow ring-shaped coil of somewhat larger diameter. These two latter coils are connected by a light cross bar, to the centre of which is attached a spiral steel spring by which they are suspended. The internal diameter of the ring coils exceeds the external diameter of the solenoids sufficiently to permit of some deflection. The coils are brought back to the zero position by means of a torsion screw attached to the suspending spring, as in the Siemens dynamometer. Several very beautiful and ingenious refinements of detail have been introduced, which can only be appreciated from a detailed description and drawings of the instrument. The dials are graduated, so that the instruments are direct reading and require no table of square roots.

The new voltmeter of Profs. Ayrton and Perry is based upon the well-known Cardew instrument. The chief object of the new arrangement is to render the instrument more portable, more constant, and more reliable in the readings of the lower part of the scale. For this purpose the platinum wire employed is only a few inches in length. It is placed horizontally, and is attached rigidly at both ends. The sag of the wire increases with the difference of potential at its terminals. To render this apparent, to the centre of the wire is attached a spring of the same description as those constructed by the authors for their well-known "spring" ammeters and voltmeters. By this means the objects aimed at have been most effectually secured, but numerous modifications and refinements of detail must be left for description in the complete paper.

DISCUSSION.

Mr. GORDON said it was not his intention to criticise the beautiful instruments on the tables before him devised by Prof. Fleming. He felt how much they owed to those who devised instruments for the practical measurement of volts, and how important it was that every practical difficulty should be eliminated. What was wanted was a voltmeter that could be as easily read as an ordinary steam gauge; they wanted voltmeters not only that skilled electricians could read, but that a driver at 30s. a week could be trusted to attend to. They wanted something extremely simple and easily looked after. For these reasons one or two criticisms occurred to him on Prof. Fleming's paper. In the first place, the dial ought preferably to be vertical rather than horizontal. They could not get a man to effectually watch all night fifteen or twenty horizontal dials. If he dozed off for a minute he could not notice them. He was constantly stooping over the table, and an instrument whose dial was placed vertically was decidedly preferable to one placed horizontally. With regard to the Cardew voltmeter, it was very satisfactory to see such a beautiful development of Captain Cardew's principle as Prof. Ayrton had shown them. But they must not forget how much they owed to Captain Cardew for having given them the principle. They must remember that was not a mere theoretical principle. His own experience of voltmeters had been this. For eleven months he had eighteen instruments. These required a great deal of attention in graduating them. They always found it necessary to keep the current on at least two or three days in order to get rid of any permanent sag. They did not trouble about the zero. He had found it convenient to take the liberty with the instrument of taking off the dials and pivoting them, and they arranged they should be able to turn the dials 30 or 50 degrees. They simply put it on the same circuit as the standard instrument, and then turned the dial till 120 volts on the dial came to where the needle was. They set the instruments every morning in this way. As to the differences of sensibility, they tried many means. There was a very important point in Prof. Ayrton's instrument. It was the only voltmeter he had seen in which there was no current in the spring, and for that reason he did not see how there was any possible source of error. In the engine room they did not care a bit whether ten volts or twenty volts could be read correctly, but it was important whether they got 110 or 111 points, and he would like to ask this question, Whether by increasing the sag or by any alteration of the sag they could make the instrument more sensible at one particular point—say, 120-volt point. He expressed the great interest he had felt in the description of the development of Captain Cardew's principle.

Captain CARDEW, in the course of a few observations, said he had seen Prof. Ayrton's pretty instrument for the first time that day. As to his own instruments, he thought he might say that since Mr. Gordon took the voltmeters in hand, they had improved very much, the greatest care having been paid to manufacture. They were totally new instruments. In concluding his remarks Captain Cardew described on the black-board a voltmeter of a standard form which, he said, anybody could make for himself.

At this stage Mr. PREECE suggested that as the papers were of great interest to many the discussion should be postponed. There was an instrument on the table they were all anxious to hear described, and he hoped the author of it, Prof. Forbes, would be induced to renew the discussion that night week.

Before the meeting was adjourned Prof. AYRTON, in reply to Mr. GORDON, said his voltmeter could be used in a vertical as well as in a horizontal position.

PHYSICAL SOCIETY.

At a meeting of the Physical Society, held on November 26, 1887, Dr. Balfour Stewart, President, in the chair, a paper was read by Prof. S. P. THOMPSON, D.Sc., on

THE ANALOGIES OF INFLUENCE MACHINES AND DYNAMOS.

The author pointed out that in nearly all influence machines there are two stationary parts ("inductors") electrified oppositely—which are analogous to the field-magnets of dynamos—and a revolving part carrying "*sectors*," which corresponds to the "*sections*" of an armature. To prevent ambiguity, Prof. Thompson proposes to call the inductors "*field-plates*," and the revolving parts as a whole an *armature*. In the Wimshurst machine both field-plates and armature rotate, and each acts as field-plates and armature alternately. In the two-field-plate influence machines there are four, and sometimes six brushes. Two of these act as potential equalisers, two as field-plate exciters, and the remaining two (if any) are generally placed in the "discharge" or external circuit. The Holtz machine having only four brushes, two serve the double purpose of potential equalisers and discharge circuit, and this machine excites itself best when the discharging rods are in contact. In this respect it resembles a series dynamo, which only excites itself when the external circuit is closed, but on opening the circuit (say by inserting an arc lamp) produces remarkable effects. So in the Holtz machine, on separating the discharging knobs a shower of sparks results. The Toepler machine (made by Voss), having six brushes, resembles a shunt dynamo and excites itself best on open external circuit. Analogies were traced between Thomson's replenisher and the Griscom motor. An example of an analogue to the compound dynamo was mentioned as existing at Cambridge in the form of a Holtz machine, believed to have been modified by Clerk Maxwell. Another analogue with dynamos is found in the displacement of the electric field when the armature is rotated, just as the magnetic field of a dynamo is shifted round in the direction of rotation. Further analogies were traced between "critical velocity" of dynamos (which depends on the resistances in the circuit), below which they do not excite themselves, and a similar critical velocity of influence machines; *e.g.*, in a Wimshurst or Voss machine the potential equalising circuit should have a low resistance if it is to excite itself readily. Self-exciting dynamos excite better when the iron is bad and retains the magnetism, and influence machines excite better when the field plates are made of paper, or such substance as can well retain a residual charge. Both dynamos and influence machines can be reversed and used as motors.

Influence machines may also be classified by their analogy with the drum, disc, and pole armatures respectively, but there is no analogue to the ring armature of a dynamo. The Clark gas lighter is a good example of a drum armature, and a diagram showing the internal arrangements was exhibited. After mentioning that the earliest rotary influence machine, Nicholson's revolving doubler, was simply a kind of revolving electrophorus, the author pointed out that metal plates passing each other with only air between would never make a good machine, as there would be a discharge through the air which would prevent the continuance of self-excitation. There should always be two sheets of glass or other dielectric between the relatively moving conductors, as if there were one only it would be discharged upon. He also observed that for an influence machine to excite itself readily it must have a good metallic working circuit. This condition is fulfilled in the Wimshurst machine, and Prof Rücker mentioned that recently, on the occasion of a visit from Mr. Wimshurst, it was found that the large machine which the inventor had presented to the Science Museum excited itself readily, though it had been left untouched for over a year.

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Mr. H. Tomlinson then showed some interesting experiments

On the Thermo-Electrical Properties of Iron.

The author finds that if one of the junctions between strained and unstrained portions of an iron wire be gradually heated up to bright redness, the current, which flows from unstrained to strained wire across the hot junction until this temperature is reached, then suddenly changes to the opposite direction. A secondary effect observed by the author is of considerable interest. If the gas flame be slightly shifted while a small portion of wire is at a bright red temperature a current is produced incomparably stronger than those usually observed, its direction depending on that in which the flame is shifted. This current is clearly due to an inequality of temperature between the two junctions of red hot with comparatively cool wire. It appears to the author that this may very possibly be due to the total absence of strain in the molecular condition of the red hot wire, while the cool wire must necessarily be in a state of more or less molecular strain, owing to the contraction which takes place on cooling.

THE BRUSSELS EXHIBITION.

Extract from the Prospectus.

Under the patronage of His Majesty the King of the Belgians, the honorary presidency of H.R.H. the Count of Flanders, and with the active support of the Belgian Government and the city authorities, it has been decided to hold an International Exhibition at Brussels from May to October, 1888. * * * * *

A special arrangement of an exceptionally favourable character has been made with regard to the British Empire Section, which will occupy an unique position in the best portion of the grounds, and be under the exclusive control and management of Mr. S. Lee Bapty, at present general manager of the Royal Jubilee Exhibition, Manchester, the splendid success of which speaks very highly for his great capacity for organisation and ability to conduct a similar undertaking to an equally favourable issue.

In the British Section it is especially desired to illustrate as fully as the space allotted will admit the vast resources of the great empire which it represents, particular regard being had to those products and manufactures which are most suitable for the Belgian market.

In addition to gold, silver, and bronze medals, exceptional inducements are offered to exhibitors, a sum of 500,000f. having been set aside for distribution in special prizes, particulars of which will be duly announced, and it is also intended to have a grand prize distribution of some millions of francs after the manner of the Art Union, all the articles in which must be purchased from the exhibits in fair proportion.

The time at disposal being comparatively short, it is earnestly requested that application for space may be sent in immediately.

SOME PROPOSED BILLS FOR NEXT SESSION.

The South Metropolitan Electric Supply Company (Limited), whose office is at Winchester House, Old Broad-street, notify their intention of applying to the Board of Trade on or before the 21st proximo for a provisional order under the Electric Lighting Act, 1882, authorising the company for such period as shall be prescribed to produce, store, sell and distribute electricity for public and private purposes within the following area :—The City of London and the liberties thereof, and the following parishes or places in the county of Middlesex, viz., St. Anne, Soho ; St. Paul, Covent Garden ; St. John the Baptist, Savoy, or Precinct of the Savoy ; St. Mary-le-Strand, St. Clement Danes, Liberty of the Rolls, the parishes of St. Giles-in-the-Fields, St. James, Westminster ; St. Martin-in-the-Fields, St. Margaret, Westminster ; St. George, Hanover-square ; St. John the Evangelist, Westminster ; together with the extra-parochial places known as Staple Inn, Lincoln's Inn, the Temple, the Close of the Collegiate Church of St. Peter, and the Victoria Embankment of the River Thames, also all or some of the parishes or places in the county of Surrey following—that is to say, St. Mary, Lambeth ; St. George the Martyr, St. Saviour (including the Liberty of the Clink), and Christ Church. The company will ask for powers to construct and maintain on lands to be acquired or leased by them within the area of supply "such central and other stations and works for the generation, storage, supply, and distribution of electricity and electric currents, as may from time to time be necessary for supplying electricity within the said area, or for the other purposes of the order," together with all buildings, engines, &c., necessary or convenient, and to lay down, maintain, &c., electric lines, mains, &c., for the supply and distribution of electricity and electric currents in the area mentioned. By other clauses the company will ask to be empowered to "open and break up streets, &c., to purchase or acquire by agreement lands and houses, and also patent rights and licences or authorities for the use of inventions or protected processes relative to the production, supply, and distribution of electricity, and to manufacture, purchase, hire, and supply meters, lamps, appliances, machinery, and apparatus for and in relation thereto ; to make charges and levy rates, &c., for the supply of electricity ; to exempt the company from the obligation to supply electricity under circumstances specified or provided in the order, and to confer on the company the powers of the Electric Lighting Act, 1882, and any Acts amending the same, and such other powers, &c., as may be necessary or expedient for carrying out the purposes of the order, which will define and limit the prices to be charged."

The United Telephone Company (Limited) will apply to Parliament in the ensuing session for an Act conferring on the company, or a company to be incorporated, powers to carry wires for telephonic communication over, along, or across any highways, streets, &c., and any houses or lands within twelve miles of the General Post Office, and within all other parts of the county of Middlesex, and giving vestries and other public bodies and companies powers to enter into agreements for facilitating telephonic communication. The Act will contain clauses giving powers to break up streets, erect posts on, and lay or carry wires for telephonic communication under or over any land, house, street, or other place within the limits mentioned, on such terms and conditions as may be from time to time prescribed by the Board of Trade, the Metropolitan Board of Works, the Commissioners of Sewers of the City of London and the liberties thereof, or other public authority, or otherwise as shall be provided by the intended Act, for the purposes of which authority will be asked for the company or the new company "to acquire, sell, manufacture under, or otherwise use any patents and licenses for the transmission of telephonic communication, and also to grant licenses to manufacture under, or use any such patents either within or without the limits aforesaid." Authority will be asked "to make, levy, and recover rates, rents, and charges," and to grant exemptions from such payments, and to make and enforce bye-laws, and to impose penalties. If found necessary or desirable the company will be dissolved, and the shareholders reincorporated with other and extended powers.

Application is intended to be made by the Society or Corporation called Lloyds for an Act empowering them to erect, maintain, and work signal stations, with all requisite telegraph and telephone wires, posts, &c., on the coast of Great Britain and Ireland, and the islands appertaining or belonging thereto, as shall be thought expedient and necessary for the preservation of life and property. The Act will also ask for powers to place and maintain posts, tubes, and wires "over or under any lands, houses, buildings, or water which may intervene between any such signal station, or signal house and any post office, telegraph station, or public highway, for the purpose of affording or completing means of telegraphic, telephonic, or electrical communication."

The Great Western Railway Company have given notice of their intention to apply for Parliamentary powers for the construction of a tramway from Oxford to Brill, "to be worked by electrical or mechanical power."—A notice issued in the name of the "Eastern and Midlands Railway" describes several tramway lines in the county of Norfolk, for which powers are to be obtained to work by "electrical or mechanical power."

The Corporation of Liverpool will apply to the Board of Trade for a Provisional Order granting powers for the use of "electrical, steam, or other than animal power" on certain portions of their tramways.

The Corporation of Bradford will apply to the Board of Trade for a Provisional Order authorising the construction of tramways in the borough, and the use of "steam or other mechanical power, or electricity," on them.

The Llanelly Local Board of Health announce their intention of applying to Parliament for an Act, by clauses in which the Board will ask for authority to control, and, if need be, to prohibit the placing of "any wire, tube, or other apparatus for telegraphic, telephonic, electrical, or other purposes," over any public thoroughfare, except with the consent or license of the Board, and on such conditions as they shall deem expedient to prevent danger or annoyance to the traffic or to passengers. The Board will also ask for powers to inspect such apparatus, and to order its repair, alteration, or removal, and in default to be enabled to execute the requisite works themselves at the cost of the owner or hirer ; and they will further ask to be relieved "from all liability by reason of any failure of or accident from any such wire, tube, apparatus, or works."

In the Bill for which the Corporation of West Ham will apply to Parliament, powers are asked for to regulate, and, if thought fit, to prohibit the placing and maintaining of posts, wires, conductors, cables, &c., over, along, across, or beneath streets or other places within the borough.

A Bill will be applied for incorporating the Margate Tramways Company with powers to construct tramways, and with authority to employ on them "animal, steam, electric, or other mechanical or motive power."

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

16,032. W. MAIN. London. Improvements in electromotors and dynamo electric machines (complete specification). November 22, 1887.

16,058. G. F. REDFERN. London. Improvements in and relating to telephonic apparatus (Seonce de Combettes, France). November 22, 1887.

16,087. J. S. FARMER Manchester. An electric contact maker, particularly applicable for use in conjunction with coin freed apparatus. November 23.

16,120. E. TYER. London. An improvement in voltaic batteries (complete specification). November 23.

16,128. W. H. MUNNS. London. Improvement in mechanical telephones (J. P. Sunderland and D. M. Monjo, United States). November 23.

16,134. T. J. JONES. London. An improvement of voltaic batteries. November 23.

16,185. W. J. S. BARBER-STARKEY. London. Improvements in electric motors. November 24.

16,217. F. C. ALLSOP. Kent. Apparatus for automatically conveying and delivering letters and small parcels by electricity. November 25.

16,228. W. F. C. WARD and E. W. WILLEY. London. Improvements in arc lamps for electric lighting. November 25.

16,296. A. FRENCH GEORGE and C. R. BONNE. London. Improvements in primary and secondary galvanic batteries. November 25, 1887.

16,325. F. T. SCHMIT. Yorkshire. Improvements in electrical switches and cut-outs. November 28.

16,333. A. B. O'CONNER and G. W. BUTTERFIELD. London. A mechanical appliance adjustable for clocks, watches, locks, railway switches, electric lights, gas lights, and other machinery, regular periodic application of power for adjustment. November 28.

16,351. A. OWEN. London. Improvements in electric belts (complete specification). November 28.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

November 26th, 1887.

275. R. E. B. CROMPTON and J. H. F. SOLL. London. Improvements in and apparatus for effecting the distribution of currents of electricity. *January 7, 1887.*

1,331. D. HALPIN and I. A. TIMMIS. London. Improvements in commutators, brushes, or contact pieces for electrical apparatus. *January 27.*

November 30th, 1887.

1,176. J. HARRINGTON. London. Improvements in musical instruments or chiming apparatus, the hammers of which are operated by electricity. *January 25.*

1,499. T. O. CALLENDEN. London. Improvements in laying and insulating underground wires intended for use as conductors of electricity.

11,200. A. J. BOULT. London. Improvements in electricity-controlled unison motors (J. F. McLaughlin, United States). *August 16.*

13,778. W. WALKER. London. Improvements in automatic electric signalling for railways and apparatus therefor. *October 11, 1887.*

PATENTS SEALED.

November 22, 1887.

14,757. W. LAHMEYER. Germany. An improved dynamo electric machine. November 13, 1886.

14,765. C. L. BOWDEN. Cheshire. Improvements in dynamo electric machines and electric motors. November 15, 1886.

11,129. H. COLLETT. London. Improvements in electro magnetic telephones. August 15, 1887.

11,188. H. H. LAKE. London. Improvements relating to the conversion of chemical energy into electrical energy, and to apparatus therefor (W. Erastus Case, United States). August 16, 1887.

11,189. H. H. LAKE. London. Improvements in apparatus for the conversion of heat into electrical energy (W. Erastus Case, United States). August 16, 1887.

November 25, 1887.

7,720. S. S. BROMHEAD. London. An improved telephone switch (C. A. Hitchcock, United States). May 27, 1887.

10,716. T. M. KNIGHT. Improvements in electric alarm apparatus. August 4, 1887.

SPECIFICATIONS PUBLISHED DURING THE MONTH.

17,084, 1886.—A. R. BENNETT. Board for mounting telephone switches, etc. (Price 6d.)

5,292, 1887.—J. H. ALLISON. (The Baxter Electric Manufacturing and Motor Co.) Electric Motors. (Price 8d.)

13,245, 1887.—E. GRAEFE. Placing railway trains in communication with an electric conductor, separate therefrom. (Price 6d.)

LEGAL INTELLIGENCE.

Callow v. Young.

The defendant in this case was, upon the application of the plaintiff, ordered to be committed to prison for breach of an undertaking whereby the defendant undertook by his counsel not to, within 100 miles of the Royal Exchange, London, carry on or be directly or indirectly concerned in the business of a telephone manufacturer. The undertaking was embodied in an order of the Court, and the solicitors of both parties signed the registrar's book. The defendant, however, secretly carried on the prohibited business by means of using the name of a third person. The defendant was cross-examined in court.

Mr. Romer, Q.C., and Mr. Oswald appeared for the plaintiff.

Mr. WRIGHT TAYLOR, for the defendant, submitted that there was nothing to show that the defendant had had any knowledge of the undertaking given in his name.

Mr. JUSTICE CHITTY, in making an order as asked, said that the defendant had given an undertaking and deliberately broken it, and, as the rights of suitors must be protected, he had no other course than to make an order. He was very unwilling to accept an uncorroborated statement by a man that he was unaware that he had given an undertaking such as that given in the present case, for it was the duty of his legal advisers to communicate with him, and it was to be presumed that the ordinary business course had been followed.

COMPANIES' MEETINGS.

The German Union Telegraph and Trust Company (Limited).

An extraordinary general meeting of this Company was held on the 28th ult., at Winchester House, Old Broad-street, for the purpose of considering a report of the Directors, and determining as to proposals made by the Imperial German Government for the acquisition of the cables and property of the German Union Telegraph Company (of Berlin). Sir James Anderson presided.

The SECRETARY (Mr. Wm. Payton) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen—I propose giving you as clear a statement as I can of the circumstances which are leading to the sudden termination of the existence of this Company—a company which, until very recent days, I regarded as likely to retain the position of doing all the submarine cable work which Germany might desire. A few weeks ago two of the leading officials of the German Postal and Telegraph Department were in London, and I believe it was then decided that Germany and the English Post Office would either acquire the existing cables or lay their own cables, and that the two Government Telegraph Administrations would work the traffic at a reduced tariff. The German Government could not of course cancel our concession, which has still eleven years to run; but this concession is not exclusive. It is worked in concert with the German Telegraph Administration. We have also agreements with the Submarine Telegraph Company, whose concessions end next year, and with the Anglo-American Telegraph Company. This latter agreement will be taken over and carried out by the German Telegraph Administration. In the latter days of October the Berlin Board of the German Union Company were called upon to negotiate for the sale of the Company's cables, or to submit to the opposition of Government rival cables, at a tariff which, even with a large amount of traffic, would have given us a very small revenue. These negotiations were carried on by Dr. Lasard, the Managing Director in Berlin, and I must say very ably carried on, and practically the result is that we are offered the first cost of the cables—one of which is seventeen years old—and we are allowed to retain our reserves. We are called upon to reply promptly. It must be admitted, as claimed by the German Government negotiators, that a sum of money offered by Germany for our property—£315,000—which, together with our reserves and the interest for 1888, would yield, if invested in German Rentes, 4 per cent. interest in perpetuity on the original share capital, cannot be called inequitable. But you will naturally say, "That is all very well for the original shareholders of the German Union Company, but what about the German Union Trust, of which we are shareholders, and who do not get par for their shares?" Well, gentlemen, I have to tell you that the German Government never recognised this Trust Company, and do not now recognise its existence, although we have always acted as the London agents of the Berlin Company. For about two years after the German Union Company laid their cables the capital was all in the hands of a few bankers and their friends, and in order to obtain a quotation on the London Stock Exchange an English Trust Company was formed, and those who had risked their money and worked the cables for about two years, and who had concluded valuable agreements, considered that they deserved some profit for their risk and labour. I beg to say I was not one of that happy number. When I joined the Company I paid £2 premium for my shares, and I considered the Company would turn out prosperous and be likely to extend its useful-

ness, as it has done, paying a dividend of nearly 6 per cent. since the commencement upon the increased capital. The original shares were £15 per share, and when this Trust Company was formed the nominal value of the shares was made £20 in two £10 shares. The amount of money now offered to us is sufficient with the reserves, interest, and dividend of 1888, to give us about £19 on the original shares of £15, and £9. 10s., or a little more, upon the shares of this Company. Of course, as the money will not be paid until January, 1889, and as there may be repairs, or accidents in the interval, the exact amount cannot be estimated accurately; but £9. 10s. to £9. 15s. is the present estimate, allowing for the usual expenses: and you must understand that these sums are made up by including next year's revenue, and as I have already said reserves and interest, and, in fact, all our resources. Therefore, after the dividends which are intended to be paid, as usual, in January and March next, there will not be any more interest, but simply a return of capital in January, 1889. I may remind you that all the Trust shareholders had an opportunity of subscribing for preference capital, and the majority of the shareholders so acted, so that all who did so will have a fair average return on their investment. I must say our first impression of the amount offered was disappointing, nor did we like the extreme urgency, as it did not give us par for our Trust Company's shares, nor adequate time to consider the proposition, and I went to Berlin, accompanied by Count Reichenbach and Mr. Payton, your secretary, to see if anything could be urged to improve the position, but the Director-General of Posts and Telegraphs, who is *ex-officio* a member of the Council of Supervision which controls the German Board of Direction, very definitely said, "There is the proposition, and I am instructed to urge its prompt acceptance, or we will lay our own cables." We have therefore returned with the conviction that it is to your interest to give us the power to accept the offer of the German Government. I may say that the Globe, which holds half the capital, have agreed to accept. This power must leave here to-night to be in time for the general meeting in Berlin on the 1st December, and the reason for this urgency I understand to be the necessity of including the amount I have named in the Budget to be presented next month in the Reichstag; or alternatively some other sum for new cables, if we decline. With these remarks I will move the following resolution:—"That the Board of Directors be and they are hereby authorised to agree on behalf of this Company to the terms proposed by the Imperial German Government for purchase of the cables and property of the German Union Telegraph Company of Berlin, and to take all such steps as they may deem necessary or expedient to have such purchase completed."

Count REICHENBACH seconded the motion.

Mr. W. GRIFFITH said he did not blame the German Government for making the proposal, for they were men of business and could see that the property they wished to acquire was a very valuable one. For that reason, however, he contended that a better price ought to be given.

Mr. S. LOWENTHAL (Brighton) acquiesced in this view, and said that his case was a very hard one. He had been a shareholder from the inception of the Company, and regarding the investment as such a good one he bought 75 more shares a fortnight ago, at something like £10. 12s. 6d. each. He had not yet got the certificate in connection with that transaction. Two or three days afterwards, however, to his astonishment, he received notice informing him of the negotiations for acquiring the property, and the shares fell to £9. 5s. He wished to know, in connection with that fall, if any of the Directors had sold shares after their cognisance of the negotiations.

The CHAIRMAN: Certainly not.

Mr. LOWENTHAL: Neither directly nor indirectly?

The CHAIRMAN: Neither directly nor indirectly.

Mr. LOWENTHAL, continuing, said he thought that the shareholders should have been made acquainted with the matter before. If necessary, he thought the Directors should appeal to the British Government in the matter.

The CHAIRMAN, in reply, said that the Directors knew no more about the matter than the man in the moon until about three weeks ago, when Dr. Lasard put before them the terms offered by the German Government, and it was—Take these terms, or we are determined to lay our own cables. That Government for some time had been in communication with the English Post Office and the other Governments—the Continental Governments—and had determined to have their own cables, to take over the concessions as soon as they expired—he meant the submarine cable concessions—and reduce the tariff. The tariff which would remain to the Company if they chose to continue working their cables would be a halfpenny a word, and if the cables were full that tariff would not do much more than pay working expenses. Moreover, they would have as rivals the English and the German Governments, a matter on which they had never been consulted. The shareholders could not, therefore, expect the Directors to go to the English Government and ask them to try and induce Germany to give them more money, when the English Government themselves were determined, having their own cables, to reduce the tariff. As a private company they would have to compete with two Governments, and work at a tariff of a halfpenny a word. The German Government maintained that they had offered a fair price for the cables in giving a sum which would return 4 per cent. in perpetuity if the money were invested in German Rentes. The Directors went to Berlin—disappointed, as the shareholders might suppose—at the beginning, and they said and did all they could; but it was of no use. The power of attorney had to go that night to Berlin, or their property would be practically worthless. That was the position which as Chairman he had to put before the shareholders, and he could not suppose that they would be so stubborn as to refuse the offer. He then put the motion, and it was carried with one dissentient.

In reply to a vote of thanks proposed by Mr. GRIFFITH,

The CHAIRMAN said: Our concessions have only eleven years to run, and what is the use of a tariff of a halfpenny a word?

The meeting then separated.

Blackpool Electric Tramway Company.

The annual meeting of the shareholders of this Company was held on Saturday, under the presidency of Mr. R. Horsfall, mayor of Halifax.

The CHAIRMAN pointed out that the Company had suffered an unfortunate mishap during the year in the failure of the line. This had put them to considerable expense in horse hire and in repairs, and then again they had had to contend against great competition from the omnibus proprietors. He complained that they were most unfairly dealt with by the Corporation of Blackpool, who allowed the omnibuses to run on Sunday, but prevented the tramcars from carrying passengers on that day. The old insulators were being replaced by new and more effective appliances, and after their experience of the past year he had increased confidence in the concern. No dividend was declared. A sum of £471 was carried forward to the reserve fund. Messrs. Kingsbury, Ormerod, Shaw, and Smith were re-elected Directors.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 25th November amounted to £4,431.

RAILWAY TRAIN TELEGRAPHY COMPANY (LIMITED).—With a capital of £3,000, in £1 shares, this company has been registered to "construct demonstrative lines of railway telegraph," with all necessary adjuncts, under patents granted to Thomas A. Edison, Ezra T. Gilliland, and Lucius J. Phelps.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended November 25th were £3,563, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

Mr. William Abbott, of Tokenhouse Yard, London, desires to state that the use of his name by a firm assuming the title of Abbott, Page and Co., was totally unwarranted.

Mr. Rashleigh Phipps desires us to state that he has taken into partnership Mr. A. R. Dawson, late of the United Telephone Company, and Messrs. Judson's Electrical Works, Southwark, and that the style of the firm will now be Messrs. Rashleigh Phipps and Dawson, carrying on business at the same address, 185 and 187, Gray's Inn-road, where Mr. Phipps has so successfully carried on business as electric light engineer and contractor.

Messrs. Laing, Wharton and Down notify that after Saturday next, December 3, their address will be 82, New Bond-street, W.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Nov. 30.		Business Done Week Ending Nov. 30. Highest.	Lowest.
Anglo-American	37½,	38½	—	—
Do. Preferred	62½,	63½	63⅜	62⅝
Do. Deferred	13¾,	14¼	14⅜	14⅛
Brazilian Submarine	11½,	11¾	11¾	11⅝
Cuba	11¾,	12¼	12¼	12
Do. Preference	18½,	19½	—	—
Direct Spanish	3½,	4	3⅞	3⅝
Do. Preference	8,	9	—	—
Direct United States Cable	8¾,	9	9	—
Eastern Telegraph	11½,	11⅝	11⅝	11½
Do. 6 per Cent. Preference	14½,	14¾	14¾	14½
Do. 5 per Cent. Debentures, 1899	106,	109	—	—
Eastern Extension	12,	12¼	12¼	12 1-16
German Union	9½,	9¾	—	—
Globe Telegraph and Trust	5½,	5¾	5 9-16	5½
Do. Preference	13½,	13⅝	13⅝	13 3-16
Great Northern	13½,	14	13⅞	13 13-16
Indo-European	37,	39	38	37
Reuter's	8,	8½	—	—
Submarine	135,	145	151	150
West India and Panama	1¼,	1½	1 7-16	1¼
* Do. 1st Preference	9½,	10	10¼	9⅝
Western Brazilian	7¾,	8	—	—
Western Union 7 per Cent. 1st Mortgage	117,	123	—	—
Do. 6 per Cent. Sterling Bonds	101,	104	—	—

TELEPHONES.

Companies.	Closing Prices. Nov. 30.		Highest.	Lowest.
Consolid. Telephone and Maintenance	9-16,	11-16	—	—
Oriental	¼,	⅜	—	—
†United Telephone	12,	12½	12⅜	12 1-16
United River Plate	4¾,	5¼	4 15-16	—

ELECTRIC LIGHT.

Companies.	Closing Prices. Nov. 30.		Highest.	Lowest.
Anglo-American Brush Light (£3 paid)	1¾,	2¼	—	—
Do. (fully paid)	2½,	3½	—	—
Swan	1¼,	1½	1¼	1⅛
Maxim Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Companies.	Closing Prices. Nov. 30.		Highest.	Lowest.
Telegraph Construction	38,	39	38¾	38½
India Rubber, Gutta Percha and Telegraph Works	21,	22	21½	21⅛

* xd. 9s. on account of arrears. † xd.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

This week we publish in another column the first of a series of New York letters, which will be continued periodically, and which we anticipate will furnish readers of *The Electrician* with the latest and most trustworthy information relating to the progress of electrical industries in America.

The *Gas World* is good enough to admit that the electric lighting industry progresses with "wond rful rapidity," and deprecates the ostrich-like policy of those who let their interests in the gas-distributing industry blind them to the advances of the rival illuminant. Nevertheless, it is satisfied that although the rivalry may be a real and serious thing one day, the day is as yet somewhere in the "unknown future." Our contemporary, however, goes on to say that "everyday experience teaches us new lessons," which is, or ought to be, conducive to modesty in forecasting the future. One of our own experiences just now has been the perusal of one figures compiled by the Bureau of Statistics in Berlin, from which we learn, among other things, that four-fifths of the steam engines now working in the world have been constructed within the last twenty-five years. Locomotives and marine engines are not included in the return, but exclusive of these England alone employs steam equivalent to 7,000,000 horse-power. If electricity is to progress with anything like the same "wonderful rapidity" we shall be content to regard the "unknown future" with resignation.

The subject of telephonic communication at sea, which has attracted additional interest in consequence of recent shipping disasters in the Channel, is rendered somewhat superfluous by Mr. Sedley Taylor's letter in *The Times* last Saturday. The detailed account of Colladon's experiments on Lake Geneva quite fifty years ago seems to indicate that the mere employment of a submerged bell or gong on the one hand, and on the other a trumpet-shaped tube with its broadest end immersed in the water, are sufficient appliances for the submarine transmission of sound to a distance of eight miles at least, even in rough weather. Reference to these experiments of Colladon's is to be found in several text-books on "Sound," and it is only surprising that the suggestion has not hitherto been turned to practical account. Recent experiments of the kind with the microphone and telephone seem to have been hitherto successful only to a distance of a mile—probably because these instruments are too sensitive, the true signal being overpowered by the disturbances of extraneous sounds close by.

Our recent article on the training of electrical engineers has called forth several communications, besides those we have published, from persons directly interested in the training of electrical engineers, among others from Prof. Garnett, of the Durham College of Science, Newcastle-on-Tyne, and from Mr. George Montefiore Levi, of the Institut Electro-Technique at the Liège University. From both places programmes are forwarded to us, showing that on the one hand mechanical engineers are required to go through a course of Electricity, and on the other that electrical engineers have to learn the principles and practice of applied mechanics. Of course, we were aware of this, our point being that the mechanics of the College cannot compare in usefulness with those of the practical workshop.

A writer in *Industries* (the abstract of whose valuable paper on "Central Station Lighting" will be found in another column) arrives at the conclusion that "electricians would be wise to devote their attention rather to the development of the battery system than to that of distribution by rotary transformers." Without going so far as to dispute this dictum we venture to think that the question will bear a little further discussion. In the particular scheme which the author has chosen for illustration the capital cost of the two systems works out in the proportion of 60 for batteries to 52 for motor generators. But the author very fairly points out that the omission of several important items, such as cost of land for the central station, and rental or purchase of premises for sub-stations, would go far to reduce this apparent superiority on the part of the motor-generators. So far, we are entirely with him, and we also agree in anticipating a decided reduction in the cost of batteries.

The divergence of our views from those of the writer in question commences at the point where he asserts that "it should be borne in mind that there is not much probability of the rotary transformer becoming cheaper in the future," on the ground that "it is nothing more than a dynamo with two circuits on the armature, and since the price of dynamos has fallen to what may reasonably be expected to be its lowest level it is difficult to see how rotary transformers could be further cheapened." The majority of our readers will not, however, experience this difficulty, inasmuch as we have quite lately de-

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scribed and illustrated a system in which the rotary transformer—or, as we prefer to call it, the motor-generator—so far from being, as the writer estimates, 25 per cent. dearer than a dynamo of the same output, should be very little dearer than an alternating current transformer. We must refer the author to our previous issues for the details of this system, expressing, by the way, a mild astonishment that so careful and evidently well-informed a critic should yet have remained in ignorance of the work of MM. Jehl and Rupp.

It is not merely on the question of cost that the Jehl and Rupp system meets the most formidable objections of the critic. One point raised is that, owing to the noise and vibration of the armatures, it would be more difficult to find suitable localities for sub-stations on this system than when batteries alone are employed. This objection, of course, falls to the ground when the transformers remain at rest and a single, comparatively light commutator is alone in motion in each sub-station. We hold no brief on behalf of motor-generators, but we certainly think that the question must be reconsidered in the light of these facts before the conclusions set forth in *Industries* are implicitly accepted.

After all it seems to us that the ideal system is more probably to be found in *a combination* of the motor-generator and battery systems. Indeed, the advantages of this combination have by no means been overlooked by those engaged in the development of each type of apparatus. On this question we shall probably have something more to say before long.

The financial record of the Blackpool Electric Tramway Company reflects in miniature, but only too faithfully, the history of far too many a joint-stock enterprise. The remuneration of the Chairman, Managing Directors, Secretary and Manager—every one of whom is of course absolutely indispensable to the success of the enterprise—absorbs 38 per cent. of the total amount paid for wages. The company is therefore very naturally unable to afford the extravagance of a practical electrician to look after the insulation of the line. If the said insulation came to grief, and if electrical traction had in consequence to be abandoned for several weeks in the height of the season; and if, as a further result, there was no dividend to declare, are the Chairman, Managing Directors, Secretary and Manager to be blamed for these things?

While writing of the Blackpool Tramway, we may be permitted to take the opportunity of offering a word of congratulation to Messrs. Elwell-Parker, on the successful working of their motors upon this line. These machines have now been in use for a considerable period under conditions which have sometimes been of an exceptionally trying character, and have proved themselves thoroughly well adapted to the work.

The reason assigned by Mr. Esson (in our correspondence columns) for the slightly unequal sparking of the brushes in a two-pole dynamo, namely, that the number of lines of force passing through the half of the armature nearest the yoke-piece will be slightly in excess of the number in the other half, seems quite indisputable from a theoretical standpoint. Nevertheless, we happen to recollect that that fearful and wonderful apparatus, the Ball unipolar dynamo, did not perceptibly spark at one brush more than at the other, as it certainly seems it should have done. Of course we all know, on the other hand, that this machine never could and never would work according to any recognised theoretical assumptions.

Mr. Mordey's observations of the phenomenon of unequal sparking were made upon multipolar machines, to which Mr. Esson's explanation would not apply. The explanation offered by Mr. Mordey in another column is certainly very interesting, and we think that there is little room for doubt that an action of the character described is really set up, and that the phenomenon is adequately explained in this way.

The problem of the direct conversion of heat into electricity on an engineering scale is not yet despaired of by any means. We have now in our possession the details of a novel method, for which we are indebted to a well-known Continental electrician. We are not at present in a position to publish any account of this method, although we look forward to doing so before long. Meanwhile we may state that although we should hesitate to assert that a final solution has been arrived at, we have no hesitation in expressing the opinion that a distinct advance has been made, and that the inventor is working upon lines which may yet lead to results of the highest importance.

The sudden and almost unprecedented rise in the price of copper is causing some uneasiness among dynamo makers and telegraph constructors; but the best authorities on the subject seem to think that the rise is only temporary, and will be followed by a fall, perhaps quite as sudden, though not so great. It should be remembered that the price at the beginning of the present year was lower than it had been for ten years past. In 1877 the price was £76, in 1880 £72, and two years later £71, from which time it has steadily fallen. The mean price appears to have been reached in 1879, 1880, 1881, and 1884, when it ranged between £50 and £60.

Madrid.—Inquiries are being made in this city as to the substitution of electric for horse traction on the street tramways.

Torquay—Theatre Lighting.—An installation of electric light has just been carried out at the Torquay Theatre, under the direction of Mr. Radcliff. About 200 incandescent lamps have been fixed.

Societe Belge d'Electriciens.—We have received the fourth annual report of the "Société Belge d'Electriciens," containing a list of the general council and a report of the proceedings for the years 1886-87.

Mill Lighting.—Messrs. Greenwood and Co., of Rockville Corn Mills, Bacup, have just completed the fitting up of their extensive mills with electric light. The work has been executed by Mr. W. Bury, Manchester.

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The Queensland Telegraph.—We are indebted to the Superintendent of Telegraphs of the Colony of Queensland for a copy of the "Report of the Post and Telegraph Department of Queensland for the year 1886."

The Atlantic Cables.—We have reason to believe that the statements of the *Central News*, published in *The Times* yesterday, relating to a threatened dissolution of the Atlantic Cable pool, are without foundation.

The Electric Light in the German Marine.—The German Lloyd Company of Bremerhaven have completed installations on twenty-two vessels, giving a total of 7,200 incandescent lamps and 44 dynamos. The machinery is furnished by the firm of Siemens and Co.

Obituary.—We regret to announce the death, at the age of 53 years, of M. Francis C. Guilleaume, which took place a few days ago at Maisenhausen. M. Guilleaume was a partner in the firm of Felten and Guilleaume, the well known wire manufacturers at Mülheim-on-Rhine.

Chatham.—The Chatham, Rochester and District Electric Lighting Company (whose offices are at 22, High-street, Chatham) are advertising for a steam engine to develop 150 indicated horse-power. We are glad to see that this local enterprise is showing signs of life.

The Glasgow Underground Railway.—Almost all the trains running between Airdrie, Hamilton, and Hyndland Station have now been fitted with electric light by means of Mr. Carswell's arrangement of a trailing conductor taking current from a central rail. The Glasgow and Helensburgh, Balloch and Milngavie services are also being provided with the appliance.

A Gas Company's Experience of Electric Lighting. — The Spencer (Massachusetts) Gas Company, who, as we recently mentioned, are running 60 arc lamps on a 6-ampere circuit, and are obtaining power from three Otto gas engines, find that, valuing their own gas at 50 cents per thousand cubic feet, the cost of fuel was at the rate of 0·75 cents per 1,200 candle-power arc lamp (nominal) per hour.

The Telephone in Italy.—The following are the statistics of the use of the telephone in Italy up to 31st October last:—

Venice	268 subscribers.	Turin	681 subscribers.
Naples	992 „	Genoa	409 „
Palermo ...	520 „	Florence ...	748 „
Catania ...	232 „	Bologna ...	375 „
Messina ...	183 „	Leghorn ...	388 „
Milan	1,213 „	Rome	1,835 „

A Century-Old Telegraph.—It is exactly one hundred years since Arthur Young made the first of his famous journeys through agricultural France; and Lady Verney reminds us in the current number of the *National Review* that on this occasion Young was introduced to "an ingenious mechanic," M. Lomond, who showed him "an electrical machine connected with a wire and a similar electrical meter at a distance where his wife writes down the words indicated by the motions of a pith ball—the length of the wire makes no difference."

Mr. Tomlinson's Experiments on the Thermo-Electric Properties of Iron.—In our report of the meeting of the Physical Society on Saturday week we inadvertently attributed to Mr. Tomlinson an observation for which Mr. de Tunzelmann was responsible. This was the suggestion that the results obtained by Mr. Tomlinson might very possibly be due to the total absence of strain in the molecular condition of the red-hot iron, while the cool wire must necessarily be in a state of more or less molecular strain owing to the contraction which takes place on cooling.

The Energy Expended in Electrical Traction.—From the experiments of M. Huber on the Ehrenfeld Tramway it appears that the storage batteries employed *receive a total charge* equal to 76 watt-hours per 1,000 kilogrammes carried 1 kilometre. This is equal to 123·8 watt-hours per ton-mile. On this line there is no gradient exceeding 2·5 per cent. M. Huber takes the efficiency of his dynamo at 80 per cent., and makes the work done by the engine equal to 95 watt-hours, or 0·13 horse-power-hour per ton-kilometre. This is equal to ·209 horse-power-hours per ton-mile.

Personal.—Mr. A. E. Kennelly, of the Eastern Telegraph Company, has accepted an appointment in Mr. Edison's laboratory at Menlo Park. Those who knew Mr. Kennelly best prophecy for him a brilliant career; but, while we congratulate him on entering so congenial a field of labour, we cannot help expressing our sincere regret at his expatriation. Prior to his departure for America a few of his many friends in the Eastern Telegraph Company presented Mr. Kennelly with a set of mathematical instruments and a handsomely bound set of Shakespeare's works, as a mark of their friendship and respect.

Electric Communication with Lightships.—At a meeting of the Dover Town Council on Wednesday last it was decided to forward a petition to the Queen, praying that immediate steps may be taken to establish electric communication between the Channel lightships and the shore. The recent disasters in the Channel were instanced as showing the urgent necessity of such communication, the "W. A. Sholten" disaster occurring within a very short distance of the Goodwin Sands Lightship. It was stated that Ramsgate, Margate, Deal, Sandwich and other coast towns had adopted similar memorials.

"**Fire!**"—A monthly journal bearing this startling title has just made its appearance, with the object of affording practical, scientific, and general information for the prevention of fire. It is published at 25, Bury-street, St. Mary-axe, E.C., and the price is one shilling. The first number, which has just reached us, contains a vast deal of useful information on the subject of fires and their causes, together with some well-considered original articles discussing the relative safety of the various systems of illumination now in use, including the electric light, and other kindred subjects of interest to insurers and insurance offices.

Finsbury Polytechnic and Working Lads' Institute.—We have been requested to state that Lord Wolseley will preside at the opening of the new Gymnasium and Social Room of the Finsbury Polytechnic, Appold-street, near Finsbury-square, on Monday, December 12, at 8:30 p.m. Since the swimming bath and temporary gymnasium were ready for use in January last nearly 400 members have been registered, and the institute is likely to prove as great a benefit to working lads of the East End as the Polytechnic in Regent-street is to those of the west. Its aims are to promote technical education and the physical and moral welfare of youths between the ages of 16 and 23. Tickets for the opening ceremony may be obtained of the secretary.

New York.—The Board of Electrical Control of New York City have adopted a standard design for lamp-posts that shall be hereafter erected by the electric light companies. The design contemplates a pole 20ft. high, exclusive of the lamp frame. For a distance of 7ft. from the surface of the ground the pole is to be of iron, and above this it will be of hard wood. This combination of materials is intended to prevent, as far as possible, all danger from shocks, as the wires carrying the cur-

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rent will not be visible at any point on the iron pedestal. The post is of ornamental design, and as no part of the pattern is controlled by any patent, any company will be at liberty to erect the poles at first cost of material and labour.

The Electric Light in Hamburg.—The commission appointed by the Corporation of Hamburg to consider the question of undertaking the supply of electric light has presented a report recommending the establishment of a central station in the neighbourhood of Jungfernstieg, the management of which is to be entrusted to the town gasworks. The prospective cost of the undertaking is a million marks (£50,000). It is proposed that the consumers should pay at the rate of eight pfennigs (4·8d.) per ampere hour, the pressure on the mains being 180 volts. Besides this, an annual rental of five marks (5s.) will be levied on each incandescent lamp, double that amount being charged for an arc lamp. A reduction more or less considerable will be made in the case of large consumers.

Electric Lighting Notes from Spain.—A correspondent of *Industries* says that the largest independent electric light installation in Spain will be that of the Royal Italian Opera House, which is being carried out by the Schuckert Company. There will be about 1,500 glow lamps, and a dozen Krizik arcs. The town of Albacete, which has a population of about 20,000, and which has hitherto been lighted by oil, is adopting the electric light for private and public lighting, 16 candle power glow lamps being employed. The installation will be ready in a few weeks. The Municipality of Bilbao, which has some surplus engine power at their waterworks, intends to utilise it for lighting the principal thoroughfare of the town by means of thirty-two arc lights. Schuckert dynamos will be used.

An Electric Waiter.—The electric dining table in a restaurant at Sacramento is described as follows:—In the room are twelve tables, with a seating capacity for sixty persons, and all attached to the long electric motor table. Printed bills of fare are on each table, and visitors order by marking on the bill, placing the same on the waiter, which is about one-half the size of an ordinary waiter, and pressing the electric button, which causes the waiter to revolve half way around and into the long table, thence into the kitchen, where the order is filled and returned to the dining room. The arrangement is neat, noiseless, clean and comfortable, and to show with what smoothness the waiter does its work a brimming glassful of lemonade was ordered, and it was served without one drop being spilled. The table avoids all the many annoyances of restaurant dining, especially of the "sing-song waiter."

A Conference on Technical Education.—The following is a copy of a circular on this subject, issued from the Royal Victoria Hall Coffee Tavern, and which is referred to in our correspondence columns: — "Royal Victoria Hall, Waterloo Bridge-road. A public conference (non-political). A friendly meeting of employers and workmen to discuss technical education will be held on Wednesday, December 14th, at 8 o'clock; doors open at 7:15. Chairman, Sir Henry Doulton, supported by other influential gentlemen. Two short papers will be read, giving the two sides of the question, one by a working man, Mr. Bockett, and one by a man of science, Dr. J. A. Fleming, to be followed by a discussion. Anyone wishing to take part in it, please send name, address, and business to the hon. sec. at the hall. All seats free by tickets. Applications for tickets to be made of commissionaire at the stage door after Saturday next, 10th inst. Full band at 7:30."

An Electric Optical Lantern of 4,000 Candle-Power.—Messrs. Cox, Robinson and Co, of Liverpool, have constructed a lantern for optical experiments, combined with a Pilsen lamp, taking 26 amperes. The latter is so fixed that only a vertical movement is possible. This is effected by a rack, with very fine teeth, allowing the smallest adjustment to be made. The condenser and object glasses are mounted together on a stage, having three movements, so that the whole can be focussed in any direction to the arc. This combination admits of a perfect centring of the light, and answers remarkably well. The enormous amount of light allows almost any size of disc, and micro-objectives can be shown 60ft. in diameter. The above arrangement obviates many of the objections that have been made to electric lanterns, and when run from secondary cells, having a good margin of available current, the light is quite as steady as the lime light. This lantern was on view at the recent Exhibition at Liverpool.

A False Alarm.—Historical Note.—In the year 1795 it was greatly feared that nothing further in the science of electricity remained to be discovered. In 1795—before Faraday, before Ampère, before Œrsted, Davy or Volta! Prof. E. J. Houston has unearthed the record of this singular fact in a volume by one Siberius Cavallo, F.R.S., entitled "A Complete Treatise on Electricity in Theory and Practice, London, 1795." The passage referred to is quoted by Prof. Houston in a letter to the New York *Electrical World*, and runs as follows:—

"Since the time of this discovery, the prodigious number of electricians' experiments and new facts that have been daily produced from every corner of Europe and other parts of the world is almost incredible. Discoveries crowded (*sic*) upon discoveries, improvements upon improvements, and the science ever since that time went on with so rapid a course and is now spreading so amazingly fast, that it seems as if the subject would soon be exhausted and electricians arrive at the end of their researches. But, however, the *ne plus ultra* is, in all probability, as yet at a great distance, and the young electrician has a vast field before him highly deserving his attention, and promising future discoveries perhaps equally or more important than those already made.

Electrical Determination of the Mechanical Equivalent of Heat.—At a recent meeting of the Berlin Physical Society, Dr. Dieterici gave an account of his experiments on the determination of the mechanical equivalent of heat by the indirect electrical method. As the result of his series of measurements, he obtained closely agreeing values for the mechanical equivalent of heat—viz., 424·4 and 424·2 as the mean of each series; the highest and lowest values obtained differing but little from the mean of the determinations. When making his calculations, the speaker took as the specific heat of water the mean of the determinations made between 0deg. C. and 100deg. C. The statements which have been made respecting changes in the specific heat of water as dependent on changes of temperature vary so greatly with different observers, that the mean values based on their results do not provide any constant factor. The speaker's determinations would have been considerably different had he taken as his basis any other value of the specific heat of water. He next compared the results of his experiments with those of earlier observers, and discussed the very marked differences in the values given for the specific heat of water at various temperatures. He thinks that the specific heat of water may best be determined by the electrical measurement of the mechanical equivalent of heat, and intends to investigate this question more fully at a later date.

A Big Magnet.—A New York paper states that Major W. R. King, of the United States Engineer Corps, has recently constructed what is probably the largest electro-magnet ever made. The account proceeds:—"He has connected at the trunnions two 15in. Rodman guns, wound them with about four miles (ultimately he will use six miles) of old torpedo-

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cable, and thus obtained, by the use of a thirty horse-power dynamo, an electro-magnet of enormous power. All the materials being already on hand, the means of really valuable experiments are thus provided almost without cost. The tests have not yet gone so far as to give quantitative results. In fact, only a preliminiary trial of the magnet (not yet fully wound) has been made, and its whole strength cannot be measured until it has been more firmly anchored. But it shows a tremendous power. One of the peculiar phenomena observed is that a 15in. shell, weighing 320 pounds, placed in the muzzle of one of the guns is violently forced out when the current passes through the wire; yet it does not leave the gun, but swings round to the lower side of the muzzle, where it remains hanging, like a carpet tack on an ordinary magnet, even with a second shell of equal weight depending from it. Twenty men cannot pull an iron rail from the muzzles of the guns while the current is passing. Major King has had an armature made of 11in. plates, built up to a thickness of 5 or 6in., so as to get a more suitable mass for the giant to work on, and a 5-ton Duckham dynamometer fails to register a force sufficient to remove it. We anticipate very interesting results from experiments with this magnet. Unless we are much mistaken, it will be by far the strongest in the world, weighing, as it does, more than 100,000 pounds."

A New Experiment in Magnetism.—The circular magnetisation which is developed in an iron wire while conveying an electric current has not hitherto afforded any direct experimental proof of its existence. Its effects in increasing the self-induction of the wire have been dealt with by Prof. Hughes, Lord Rayleigh, and others. We may also mention the proof afforded by Wiedemann's experiment on the longitudinal magnetisation of an iron wire conveying a current when submitted to torsion. But owing to the magnetic circuit being closed in the iron itself, direct experimental evidence of circular magnetisation was not forthcoming. A very simple and conclusive experiment has, however, been devised by M. Paul Janet, and formed the subject of a note recently presented to the French Academy by M. Mascart. M. Janet takes a cylinder of iron 30 centimetres in length by 1·5 centimetre in diameter, which has been cut longitudinally in halves and fitted together with great nicety. A current of from 30 to 50 amperes is passed through the cylinder for a few seconds. The two halves are then separated. A sheet of paper is placed upon one of the two plane sections, and dusting iron filings on this we find that, except near the ends, the filings arrange themselves in straight lines perpendicular to the two generating lines of the cylinder which form the longer sides of the rectangular boundary of the section. At the two extremities of the section the filings are arranged in curved lines, with their convex sides outwards. This shows clearly that the two generating lines are the *loci* of the poles of a series of semi-circular magnetic filaments, so that the whole cylinder must be built up of a series of annular magnets concentric with the axis, and magnetised with an intensity increasing with their distance from the centre, which is the distribution of magnetism indicated theoretically. A further verification may be obtained by suspending a magnetised needle parallel to one of the plain sections placed horizontally, when the needle will set itself perpendicular to the axis of the cylinder.

The Submarine Telegraph Company.—The *Central News* states that the negotiations between the French and English Governments for the joint working of the submarine cables have progressed so far that no doubt is now entertained that a satisfactory arrangement will be arrived at. After the return of M. Coulon, the French Postmaster-General, to Paris, the negotiations were continued by M. Waddington, the French Ambassador, and the provisional agreement arrived at has been taken by His Excellency to Paris for ratification by his Government. In the meantime, the directors of the Submarine Telegraph Company, who were despatched to Paris with a view to influencing the French Government in their behalf, have returned to London, and reported the failure of their mission. The French Government are so far committed to the proposals of the English Ministry that they distinctly decline to consider the question of any prolongation of the concession to the Submarine Telegraph Company. The English Government have been equally firm, the final resolution of the Cabinet just communicated to the Submarine Company setting forth that, having thoroughly examined the question, they have "decided not to grant a prolongation of the Company's license to land cables on British shores, and not to renew after the 12th of January, 1889, the working agreement between the Postmaster-General and the Submarine Company." The Post Office is desirous of dealing generously with the working staff of the Submarine Telegraph Company, recognising that it is a large and deserving one. As far as the cables are concerned the four which connect with France are in good order, recent repairs having made them almost as good as new. The two single cables to France now used by the American Telegraph Companies are also working very well. The two Belgian cables are in a fair condition. The telegraphic rate between England and France will when the final transfer is effected be reduced to twopence per word; but the special rate for press telegrams has not yet been fixed.

The Consolidated Electric Light Company of America.—The Consolidated Electric Light Company, owning the Sawyer-Man patents in America, has recently entered into several important engagements with other companies, which seem to portend a powerful combination against the Edison interest. The engagements are described as follows:—(1) It has granted to the Thomson-Houston Electric Company a license to manufacture and use incandescent electric lamps and attachments in plants and stations established by that company, in combination with its extensive and popular arc lighting system, upon an agreed royalty; and has also entered into a contract with that company whereby the interests of both companies, in the manufacture and sale of electrical apparatus other than that covered by the Sawyer-Man patents, are mutually promoted. (2) It has purchased from the Westinghouse Electric Company its valuable electric lamp factory and equipment at Pittsburgh, Pa., with a guaranteed capacity of 5,000 incandescent lamps per day; and has entered into an agreement with the Westinghouse Company whereby the purchasers from that company of its alternating apparatus for central station lighting shall also purchase from the Consolidated Electric Light Company the Sawyer-Man lamps and attachments for use with such apparatus, and shall have the protection of the Sawyer-Man patents. (3) It has purchased the stock and assumed the control of the Sawyer-Man Electric Company, which has heretofore been its sole exclusive licensee, and will conduct its commercial department through the agency of the Sawyer-Man Electric Company. It has purchased extensive manufacturing and business premises in the city of New York. To meet the increasing business demands of the Westinghouse Company, the Thomson-Houston Company, the Sawyer-Man Company and the general public, the Consolidated Electric Light Company will, within a short time, manufacture at its combined factories at least ten thousand electric lamps, with the necessary electrical attachments, per day.

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SOME ENGLISH CENTRAL LIGHTING STATIONS.

I.—BRIGHTON.

In the autumn of the year 1881 Messrs. Hammond and Co. (since deceased) commenced to run at Brighton a small arc light installation, consisting of a sixteen-light Brush dynamo, driven by a twelve horse-power (nominal) Robey engine. From this small beginning the installation has steadily increased in importance until to-day it consists of five forty-light machines, supplying 34 arcs and over 1,500 incandescent lamps.

The station has from the first been under the sole charge of Mr. Arthur Wright, Electrician, and now also Managing Director of the local company. Mr. Wright, however, possesses far higher claims to distinction as an electrical engineer than have yet been named. He has devised and carried out, with the valuable help of Mr. G. F. Philpot, the under-electrician, and with unqualified success, an entirely unique system of constant current multiple-series distribution. For this purpose he has designed instruments and methods of working which are alike characterised by remarkable beauty and ingenuity, and by a practical and workmanlike construction which has enabled them to stand the test of prolonged and successful operation. These various apparatus and methods are for the most part in use nowhere else than in Brighton, and have never before been described in print.

There can be little doubt that prior to the introduction of transformers this installation constituted the most successful instance of long-distance distribution—not merely in this country, but anywhere in existence. With the advent of induction methods the high-tension direct current system has necessarily lost much of its general importance, but whatever may be its future the Brighton scheme will always possess considerable historical interest. It is scarcely necessary to observe that the great advantage of any practicable constant current system of distribution lies in the extreme flexibility of the method. This flexibility is apparent in two directions. In the first place any kind of arc or incandescent lamp, of any voltage and any candle-power, can be run on any part of the circuit; and, secondly, the question of the proportion of the mains, which so bristles with difficulty in the parallel system, is here entirely obviated, and a loop may be run out anywhere without any consideration for other parts of the circuit.

Seeing, then, that we have so much that is interesting to relate (without staying to give a connected history of the undertaking), we shall prefer to proceed at once to the system and appliances at present in operation, noting, however, the improvements which have been introduced from time to time in the details.

The Engine House.

The Brighton Electric Light Station is situated in Gloster-road, within a few hundred yards of the terminus of the L. B. and S. C. Railway. It is thus placed fairly in the middle of the town on the line from E. to W., though somewhat to the north of the exact centre. The engine house is a building measuring 70ft. by 55ft., and of good height. The facilities for shifting coal and ashes, &c., are excellent, and water is laid on from the town mains. Fig. 1 is an illustration of the exterior, taken from a photograph.

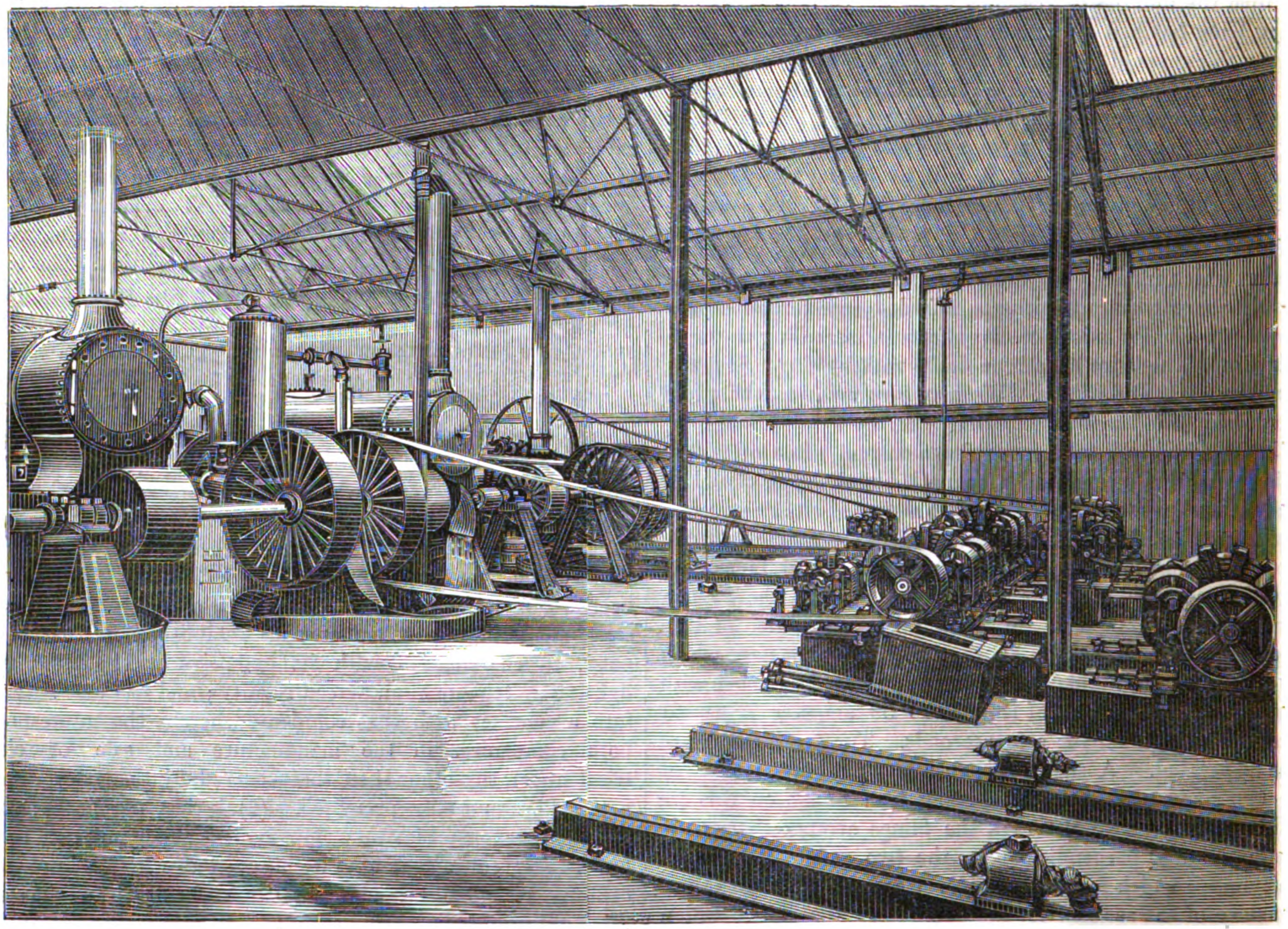

Fig. 1.

The Engines.

Motive power is furnished to the dynamos by two compound engines, each of 200 horse-power actual, by Fowler and Sons, of Leeds. These engines are of the semi-fixed type, with locomotive boilers over the cylinders. Mr. Wright speaks very highly of their performance, each engine being easily capable of developing four times its nominal power. There is also one smaller engine, by Hornsby and Sons, of 35 indicated horse-power, and of similar general description, used chiefly for the

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day circuit. These three engines run at a maximum speed of 90 revolutions per minute, and drive on to the same countershaft by treble leather belting. There being plenty of space to spare in the shed the countershaft is on the floor level, the engines being in a row on one side and the dynamos on the other. The feed water passes through a Stanhope purifier, which reduces the hardness from 15 to 2 degrees. This apparatus costs very little for maintenance, and does its duty most effectually in saving the boilers from scale. The boilers are only washed out every three months, which is a very important consideration in a constantly running system.

The Dynamos.

There is nothing remarkable about the dynamos at Brighton except that, though continuing to do excellent service, they are of a type now considered obsolete. They are, in fact, early Brush machines with the "solid" armature. There are five machines of the 40-light type, giving 10·5 amperes and 1,800 volts at 900 revolutions, and one 16-lighter giving 800 volts, with the same current at the same speed.

The Method of Regulation.

As soon as it had been decided to make the experiment of running incandescent lamps in multiple series upon the arc

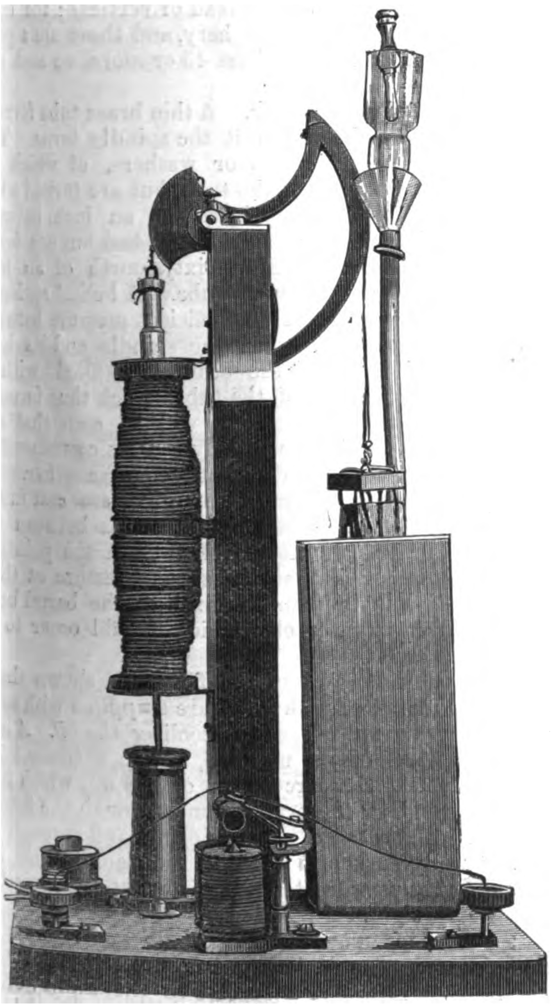

Fig. 2

light circuits (this was in 1883), Mr. Wright arrived at the conclusion—which his subsequent experience induces him strenuously to maintain—that for the economical working of central lighting stations it is essential that the speed of the engines should be varied in proportion to the output, in order to allow the engine to run as slowly as possible.

The method of regulation at first employed consisted in the use of a Brush pattern regulator in the form of a carbon resistance used as a shunt upon the field coils of the dynamos. The regulation was effected by hand, a boy being employed to watch an ammeter in the main circuit. This arrangement, though answering fairly well for arc lamps, proved unsatisfactory when incandescent lamps were placed on the circuit. Not only did the boy too often go to sleep, but the adjustment was neither sufficiently delicate nor as prompt as desirable, and the introduction of incandescent lamps as a portion of the resistance proved only a partial remedy. At the suggestion of Mr. Swinburne in October, 1884, a liquid resistance was substituted with considerable advantage; but the necessity for an automatic method of regulation become increasingly obvious.

The method by which this was eventually accomplished forms a unique feature in the Brighton system. So perfectly does the apparatus fulfil its purpose that the current is constantly maintained within 1 per cent. of the normal value.

Fig. 2 is an illustration taken from a photograph of the regulating apparatus. On the right-hand side is seen a vessel containing pure water, and through which a stream of water slowly trickles from the funnel seen in the upper part of the figure. In this vessel is suspended a pair of copper plates, between which is a platinum anode cut to the shape of inverted triangles, and hung point downwards, so that the liquid resistance between them varies rapidly as they are raised from or lowered into the vessel. These plates are connected with the terminals of the field coils, forming a shunt circuit. As will be seen in the figure, they are suspended from a form of sector which is pivoted on a standard at the back. A soft iron core hangs from the opposite side of the sector and descends into a solenoid. This solenoid is furnished with two windings, one upon the upper and the other upon the lower portion of the reel, but each so wound as to give a uniform magnetic pull throughout the length of the core's path. So far there is nothing especially novel in the arrangement; but now comes a very beautiful and highly characteristic device, which is intended to obviate the difficulty of "hunting," and which admirably fulfils its purpose. We are not at liberty fully to disclose the nature of the device in question (some portion of which can, however, be seen in the figure), but this much we may state: So long as the main current remains at its normal value momentary currents are sent through the two halves of the solenoid alternately; if, however, the main current should increase, then the successive momentary currents pass through the upper winding *more frequently* than through the lower, say, for instance, in the ratio of four to three; if the increase in the main current still continues this ratio also increases until perhaps it reaches two to one. The core therefore rises in the solenoid, the copper plates descend, and the field is weakened; the reverse action, of course, takes place when the main current tends to diminish. This highly ingenious arrangement effectually prevents any "hunting" tendency, and forms the most effective current regulator with which we are at present acquainted. The speed of the engines, which is regulated by hand, is, as already explained, always kept as low as possible, with a view to economy. It is therefore arranged that when the automatic regulator approaches the position in which the shunt on the field of the dynamo has the highest resistance—that is, when the electrodes are lifted nearly out of the bath—an electric bell is thrown into circuit, and the speed of the engine is then increased by the attendant. In a similar way a signal is given when the speed may be decreased. When several of the machines are working in series (which, as we shall more fully explain later, is the normal condition) it will easily be seen that it becomes necessary to arrange matters so that the signal to increase speed may be given by any one of the regulators; but, on the other hand, the signal for decreased speed must only be given when all the machines have mutually agreed to the alteration. This demand furnishes a very pretty little problem in circuit connections, and it has received a very complete solution in the present instance.

Ammeter.

While engaged in perfecting the regulator the necessity for obtaining a reliable ammeter was forced upon Mr. Wright's attention. On one occasion considerable trouble was experienced with the Brush lamps, and eventually this was traced to the fact that while the Ayrton and Perry ammeter in use continued to indicate the normal current, in reality the current

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had fallen off in six months to little more than 7 amperes (!). The apparatus devised by Mr. Wright, and which has given perfect satisfaction, is seen in Fig. 3.

The scale of this particular instrument is so calibrated that at 10·5 amperes the index stands in the centre, and the closeness with which the regulation is effected may be judged from the fact that while the index moves continuously over a small arc on either side of the point, yet the extreme limit of the scale employed is only ·1 ampere from one side to the other.

Fig. 3.

This instrument is only a vertical solenoid which pulls down, more or less, a steel rod (always saturated) against a counterpoising weight.

(To be continued.)

THE CLARKE, CHAPMAN AND PARSONS TURBO-ELECTRIC GENERATOR.

In our report of one of Prof. Garnett's lectures on the electric lighting of the Newcastle Exhibition we mentioned that one of the chief features of the lecture consisted in the description of Messrs. Clarke, Chapman, Parsons and Co.'s turbo-electric generators employed in supplying current to the large incandescent lamps in the main courts of the Exhibition. A machine capable of giving an output of about 5 E.-H.-P. was exhibited complete on a small drawing room table, and one of the largest sizes of motors of the triple-expansion type was shown dissected, so as to exhibit the spindle and the interior of the barrel or cylinder with its rows of guide blades.

The accompanying figure represents one of the smaller sizes of turbo-electric generators, of which eighteen of different sizes were exhibited in the Exhibition, and the following detailed description of these remarkable machines will, no doubt, prove interesting :—

The steam pipe is attached at the flange immediately to the left of the pressure gauge. Below the pressure gauge is the throttle valve, controlled by the magnetic regulator. In the figure the barrel is shown of uniform diameter throughout its length, but in larger sizes the diameter is increased twice in passing from the centre to either end, practically converting the engine into a triple-expansion engine. The steam enters the barrel at the centre, passes through the succession of turbines to either end, whence it passes through a steam-way cast in the lower part of the barrel, and finally exhausts at the centre just below the admission port. The spindle is of steel, and carries a number of brass discs, reduced near the periphery, where the blades are cut to half the thickness they possess at the centre. The projecting ring thus formed has helical teeth cut upon it, constituting the moving blades, the pitch of the teeth varying along the length of the barrel to allow of the expansion of the steam. The discs are made of such diameter as just to turn freely with the spindle within the barrel, without risk of contact with the interior of the rings which carry the fixed blades. The spindle is made very stiff, so as to allow the clearance to be made exceedingly small, as it is found that the loss of power due to the friction of the spindle and its bearings is exceedingly small, and it is very desirable to prevent, as far as possible, the passage of steam between the barrel and the discs. Between each of these discs there is an annular wheel, with helical teeth, corresponding to those on the disc, but sloping in the other direction. These form the fixed or guide blades. The annular wheels are fitted closely within the barrel, the teeth projecting from one-half of their width only, and it is within the smooth cylindrical portions of these annular wheels that the moving blades or teeth of the discs actually turn. The barrel thus contains a double series of sirens very similar in principle to Helmholtz's double siren, only that the axis is horizontal instead of vertical; the holes in the discs are cut around the periphery, and there are a great number of pairs of discs, sometimes 45 or more, on each side of the centre.

The bearings are of great length. A thin brass tube forms a sleeve around the spindle, and in it the spindle turns. This tube is carried on a series of discs or washers, of which the alternate discs fit the outside of the tube, but are turned so as to allow a clearance of one-sixty-fourth of an inch between them and the bed, while the others fit the bed but are bored out so as to leave a clearance of one-sixty-fourth of an inch between their interior and the brass tube. A helical spring at the end of the bearing produces just sufficient pressure between the discs to carry the weight of the spindle and its load, while the last half inch of the bearing is filled with a washer bored out to the size of the tube, which thus forms a guide to keep the spindle true. It will be seen that any slight flexure of the spindle will only cause a corresponding transverse displacement of the discs between one another.

In the triple-expansion engines steam-ways are cast in the upper part of the barrel, making connections between the right and left portions of the barrel at both the points of enlargement. This equilibrates the steam pressure at these points, and prevents more than one-sixth of the barrel being thrown out of work if any obstruction should occur to the passage of the steam.

In the front, at the centre of the figure, is shown the oil vessel, the pipes connected with which are supplied with copper gills or radiators for the purpose of cooling the oil. A small screw on the spindle of the machine, at the extreme left of the figure, maintains the circulation of the oil, which flows continuously through all the bearings and through the interior of the armature. The rapid passage of the oil through the armature materially assists in keeping the temperature low, notwithstanding the very great electrical output of the machine in relation to its weight.

One of the most ingenious features of the generator is the magnetic governor. The field-magnet is shunt wound, but not nearly saturated. Hence any increase in the E.M.F. of the dynamo increases the magnetism of the field-magnet. Above the yoke is pivoted a bent iron bar, which is attached to a spring similar to the hair spring of a watch, so that this bar is mounted exactly like the balance wheel of a watch. Projecting from this iron bar at an angle of about 45deg. is a gunmetal fork, the extremities of which are formed with sharp edges and move immediately in front of the opening of the small copper tube which is seen in the upper part of the figure. This tube communicates with a circular bellows, shown above the left end of the barrel. The bellows are kept distended by a spring, but a small turbine on the spindle of the motor tends to exhaust the air and make the bellows collapse under the atmospheric pres-

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sure. The throttle valve which regulates the steam supply is connected with the movable back of the bellows, the rod passing through a gland in the fixed front. When the iron bar above the field-magnet is inclined about 45deg. to the axis of the machine, the end of the copper tube is fully open, and air enters the bellows as fast as it is exhausted by the turbine, and the throttle valve remains fully open. If the E.M.F. increases, the iron bar turns in the direction of the lines of force against the constraint of the "hair spring," the end of the fork closes the air pipe, the bellows collapse under the exhaust of the little turbine, and the steam is shut off by the throttle valve. The action of this governor is so prompt, the moment of inertia of the moving parts of the machine being so small, that nearly all the load may be turned off the machine with scarcely a perceptible change in the brightness of the lamps remaining.

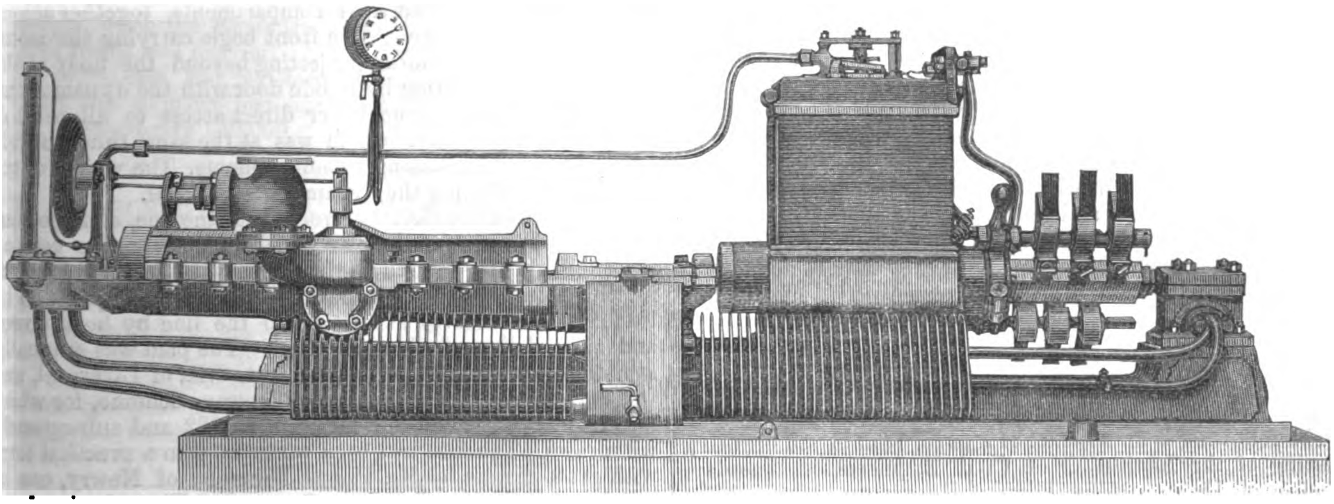
A common test of the governing arrangements of an electric light engine consists in suddenly breaking the conduction of the armature, so as to take off the whole of the load, and observing whether, under these circumstances, the engine runs away. If the connection between the armature and the field-magnet is broken, the latter of course loses its magnetism, and the magnetic governor swings back under the action of the spring only. The result of this is to bring the other prong of the fork in front of the opening of the air tube and by checking the influx of air to the bellows to cut off the steam supply.

It will be seen from the figure that the commutator is made of very great length. The brushes are of wire and press nearly "end on" to the commutator. The six brushes can be shifted into any position so as to keep the wear of the commutator even. The armature is of the cylinder type. The core is built up of thin charcoal iron plates, separated from each other by thin discs of paper. The discs are clamped up tight by two brass discs threaded on the shaft. The coils, which are laid in channels cut in the iron, are 30 or 40 in number, of stranded or solid copper wire, and each makes one complete turn. The whole is bound round with steel piano wire. The commutator segments are connected each to the ends of two adjacent coils, connected up in parallel. There are therefore 15 or 20 commutator bars.

The speed varies according to the size of the machine from 9,000 to about 10,000 revolutions per minute. The loss of power in the armature and field-magnet coils on the large machines amounts to only about one and a-half per cent., the high speed allowing exceedingly small resistance to be employed in the armature. A machine with an output of 32 electrical horse-power in the outer circuit is about 10ft. 6in. in length, and 1ft. 6in. in breadth. A small machine running a lamp of 1,000 candle-power, besides a number of smaller lamps, was exhibited in the Newcastle Exhibition, suspended by three wires. The exhaust pipe was of india rubber, and the steam pipe was provided with a flexible joint so that the machine could be shaken about while running. Properly suspended, such a machine would make a good gyroscope, and might be employed on ship-board, in connection with a Bessemer cabin, as well as for lighting purposes.

The oil is raised from the reservoir to the level of the screw propelled by the same turbine that exhausts the bellows of the governor. Exceedingly little oil is required. It is stated that in the smaller machines a pint of oil will last a fortnight. The E.M.F. of the machine can be regulated within moderate limits by adjusting the hair spring in the same way as the rate of a watch can be regulated.

From their extremely small size and weight relative to their output, and from the fact that the motion is one of pure rotation, with the parts perfectly balanced, and all the stresses, therefore, self-contained, it is obvious that these generators can be employed in many cases where ordinary engines and dynamos would be inadmissible. The locomotive, "Emigrant," built by Messrs. R. and W. Hawthorn, Leslie and Co., for the Midland Railway of Western Australia, was furnished with an incandescent search light, and was exhibited at the Newcastle Exhibition with a small turbo-electric generator in the cab.



THE CLARKE, CHAPMAN AND PARSONS TURBO-ELECTRIC GENERATOR.

ON THE UNEQUAL HEATING OF DYNAMO BRUSHES.

BY W. M. MORDEY.*

Probably many who have had an extended experience of the practical working of dynamos or motors may have frequently noticed that one brush shows a greater tendency in heat and spark than the other, or is more difficult to adjust to a non-sparking position than the other. The difference is generally very slight, and in good modern dynamos, in which the sparking has been reduced by well-known means to a negligible amount, it may be altogether imperceptible, except, perhaps, when an excessive current is being collected.

It has been supposed that this effect is caused by some inequality in the magnetic field, or that it has arisen from unequal pressure of the brushes against the commutator, or from some other mere matter of adjustment; but it appears to be something more than this. The view that an irregularity in the field is the cause of it is not borne out by its occurrence in the Victoria dynamos, for in them the cross-connecting of the armature, by bringing opposite portions of the winding into connection with one and the same brush, must have the effect of neutralising any such action.

The writer has sought in various directions for an explanation, and as he has reason to believe that the effect in question has frequently puzzled those who have observed it, and further, as it is believed that no explana-

* This Note has been in our hands for some three months, but has been withheld at the writer's request, in the hope that he might find an opportunity of obtaining further confirmation of the effect referred to. It has been thought well to give it now, the subject having recently been under discussion, as reported in our last issue.—Ed. E.

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tion or notice of it has ever been published, he ventures to give his own view in the hope that he may either be supported by others or may elicit some more correct explanation. The difficulty is that the effect is so slight—it is, indeed, hardly ever of any practical importance—that it is only by a considerable amount of observation of a large number of dynamos that any reliable opinion can be formed as to its cause.

Neither an irregularity in the field, nor an irregularity of pressure of the brushes on the commutator, nor a variation of the shape and size of the brush surfaces is, in the writer's opinion, the explanation, although any of these may occasion an unequal amount of sparking much greater than that now being considered. The effect he believes to be due to a kind of electrolytic action—that is to say, to the action, whatever it may be, which causes matter to travel in the direction of the current, as exemplified, for instance, in the electric arc, in which the positive electrode is more quickly disintegrated and is heated more than the negative electrode

This view has received some support from observations of the action of dynamos and motors, in which it has been noticed that in dynamos the brush which is positive to the internal and negative to the external circuit is the seat of the slightly greater amount of sparking and heating, the reverse of this holding good of motors. A confirmation of this explanation has been supplied by a change of the sparking from one brush to the other when the polarity of the field-magnets of a dynamo—and therefore of the brushes—has been reversed, all the other conditions being maintained unaltered.

It may, perhaps, be objected that the electric arc effect should be equally present at both rubbing contacts; but it must be remembered that where the current passes from the commutator to the brush, the commutator, which is large and heavy, is constantly offering a fresh surface to the brush; whereas the brush, which is positive to the commutator, is comparatively small, and has its contact surface always in action.

It would be interesting to find whether any action of this kind has been noticed in what are called unipolar dynamos, as in them the generation and collection of current is a perfectly even and continuous process, unaffected by any of the disturbing effects which—however much they may be reduced—are inseparable from the principles of construction of ordinary dynamos.

THE BESSBROOK AND NEWRY TRAMWAY.

BY DR. E. HOPKINSON.

The following is an abstract of a paper read at the ordinary meeting of the Institution of Civil Engineers on Tuesday, the 6th of December, by Edward Hopkinson, M.A., D.Sc., A.M.I.C.E. :—

"Although a number of electrical tramways had been constructed in the United Kingdom during the last few years, there had hitherto been no attempt at the regular haulage of minerals and goods, nor at the operation of cars larger than the ordinary tramway type. Probably in no case had the effective power of any single motor exceeded about 4 horse-power. The principal object of the present paper was to describe the construction and to discuss the working of the Bessbrook and Newry Electrical Tramway, which had been designed for the haulage of heavy goods as well as for passenger traffic. The length of the line was rather more than three miles, with an average gradient of 1 in 86, the maximum gradient being 1 in 50. According to the conditions of the contract ten trains were to be run in each direction per day, providing for a daily traffic of 100 tons of minerals and goods, and capable of dealing with 200 tons in any single day, in addition to the passenger traffic. The electrical locomotive was to be capable of drawing a gross load of 18 tons on the up-journey, in addition to the tare of the car itself and its full complement of passengers, at an average speed of 6 miles per hour, and a load of 12 tons at an average speed of 9 miles per hour. Also, the cost of working, as ascertained by six months' trial, was not to exceed the cost of steam-traction on a similar line. The line was formally taken over by the company, as having fulfilled the conditions of the contract, in April, 1886, and had since been in regular daily operation. It was worked entirely by water-power, the generating station being adjacent to the line at a distance of about 1 mile from the Bessbrook Terminus. There were two generating dynamos of the Edison-Hopkinson type, driven by belting from the turbine shaft, which was extended into the dynamo shed for the purpose. The turbine could develop 62 horse-power, and each dynamo was intended for a normal output of 250 volts 72 amperes, though they were capable of giving a much larger output. The current was conveyed to the locomotive cars by a conductor of steel, rolled in the channel form, laid midway between the rails, and carried on wooden insulators nailed to alternate sleepers. The conductor was not secured, but was simply laid upon the insulators, which fitted into the channel, and while allowing for longitudinal motion to compensate for changes of temperature, held it laterally. At one point the line crossed the county road obliquely, the crossing being 150ft. in length. In this case the conductor on the ground level was not feasible, and an overhead conductor on Dr. John Hopkinson's system was substituted, by which the collector on the car consisted of a bar only, which passed under the supports of the overhead wire, and made a rubbing contact with its under surface. This system had been found to give very satisfactory results in practice.

"The locomotive equipment of the line consisted of two passenger cars, each provided with a motor. The body of the car was carried on two four-wheeled bogies, the motor being fixed on the front bogie, so as to be entirely independent of the body of the car. The longer of the two locomotive cars was 33ft. in length, and was divided into three compartments, the front one covering the motor, and the two others forming first and second class compartments, together accommodating 34 passengers. The front bogie carrying the motor had an extended platform, projecting beyond the body of the car, and communicating by a slide door with the dynamo compartment, thus giving the driver direct access to all parts of the driving machinery, which was at the same time entirely boxed off from the passenger compartments. The weight of the locomotive, including the dynamo, was 8½ tons.

"Apart from the electrical working of the line, an important and novel feature was the plan by which the waggons used on the line could also be used on the ordinary public roads, so avoiding the necessity of trans-shipment, and enabling goods to be loaded at the wharves and drawn to the line by horse-power and again delivered where required. The plan was originally suggested by Mr. Alfred Holt, M. Inst. C.E., of Liverpool, and was embodied in the Lancashire Plateways Scheme, for which a Bill was lodged in the autumn of 1882 and subsequently withdrawn. The idea had been worked out in a practical form with great success by Mr. Henry Bancroft, of Newry, one of the directors of the Tramway Company. The wheels of the waggons were constructed without flanges, with tyres 2¾in. wide, which was sufficient for use on ordinary roads. Outside the tramway rails, which weighed 41·25lb. per yard, second rails were laid, weighing 23·75lb. per yard, with the head ⅞in. below the head of the larger rails. The flangeless wheels ran upon these lower rails, the ordinary rails forming the inside guard. The front part of the waggon was supported on a fore-carriage, which could either be pinned or allowed freedom of motion as in an ordinary road vehicle. There was a single central coupling arranged to engage in a jaw on the fore-carriage, so as to guide it when not pinned. Shafts were attached to the fore-carriage when the waggon was to be used on the ordinary roads. The waggons were of sufficient strength to carry a load of 2 tons, and their weight without the shafts was 23¼cwt. Experience had shown that the wear and tear, both on the wheels and rails, was not excessive, and that the traction did not much exceed, if at all, that of ordinary trucks with flanged wheels. No difficulty had been found with the horse-traction on ordinary roads, and the taking on and off was conducted with great rapidity.

Each locomotive-car was fitted with an Edison-Hopkinson dynamo, which was geared by means of helical-toothed wheels, and a chain to one axle of the bogie. The special construction of driving chain, rendered necessary by the severe conditions under which it had to work, was fully described. The trains were commonly composed of one locomotive car and three or four trucks; but frequently a second

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passenger car was coupled, or the number of trucks increased to six. Thus a gross load of 30 tons was constantly drawn at a speed of six or seven miles per hour, on a gradient of 1 in 50. The cars could be reversed by reversing the current through the motor without change of lead, but as there was a loop at each end of the line, reversal was only required when shunting in the sidings. The terminal loop-curves were of 55ft. radius only, but these were traversed by the long locomotive cars with perfect ease, to which the method of carrying the motor-dynamo on the bogie largely contributed.

The author concluded the paper with a discussion of an extended series of experiments to determine the efficiency of the whole combination under various conditions, and the distribution of the losses. The results were illustrated in a graphic form by a series of curves. Under average conditions of working the total electrical efficiency was shown to be 72·7 per cent., the losses being distributed thus :—

Loss in generator	8·6	per cent.
„ leakage	5·7	„
„ resistance of conductor	6·6	„
„ motor	7·7	„

The friction of the bearings in both generator and motor, and the power lost in the driving gear, were excluded from these results.

In an appendix to the paper the cost of the electrical equipment of the line was summarised, and the cost of haulage per train mile was shown to have been 3·3d. over one period of five months, when the goods traffic was light, and 4·2d. when the goods traffic was heavier. Since the opening of the line the locomotive cars had registered a train mileage of 40,000 miles, and the tonnage had exceeded 25,000 tons, and the number of passengers 180,000.

THE PROPOSED ASSOCIATION OF ELECTRICAL ENGINEERS.

With reference to the proposal to call a preliminary general meeting of electrical engineers for the purpose of discussing the new association, we are given to understand by those who have now the movement in hand that it has been found on inquiry among the leading firms of the metropolis that as no serious business could be undertaken between now and Christmas, the meeting will stand over till the turn of the year.

THE FAILURE OF THE BOILERS AT THE VIENNA OPERA.

On this subject the following additional information has reached us :—Six steel boilers, 120—140 horse-power each, were made for Messrs. Crompton and Company by the Witcourtz Iron Company in Moravia. Messrs. Crompton specified that the material used should be the best mild steel ordinarily used for boiler making. From the very first, however, the steel actually used began to give trouble; one of the plates in the water leg cracked under cold water pressure when it was tested, before steam was got up, and two other boilers failed within 48 hours of starting work. These defects admitted of temporary repairs ; meanwhile work was carried on with the other three boilers. After about twelve weeks' work, however, similar cracks began to show themselves in the main shell of the boilers, which were then considered dangerous, and the work was stopped by order of an Imperial Commission. The cracking is one of those instances which so often occur with steel boilers ; we may instance that of the Czar's yacht, the "Livadia," and which at the time excited great interest among the marine engineers. The cracks in nearly all cases appeared when the boilers were cooled down and opened up for cleaning purposes. The steel used was Bessemer, produced by the basic process. The whole of the six boilers were got out from the underground boiler house, and two large-sized locomotive boilers that happened to be available were got into position, and steam got up within nine days of the order to stop the defective boilers. The Opera was lighted on the tenth day. The whole of the rest of the machinery was found to be in perfect order, the accumulators not having suffered in the least. With the exception of this one failure of the boilers there has been no hitch whatever in the running of this large installation of 6,000 lights since the commencement.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

The general annual meeting of this society was held last night at the Institute of Civil Engineers, Great George-street, Westminster, when the undermentioned officers and council for the ensuing year were elected :—

OFFICERS AND COUNCIL FOR 1888.

President :
EDWARD GRAVES.

Vice-Presidents :

J. Hopkinson, F.R.S.	Prof. Ayrton, F.R.S.
William Crookes, F.R.S.	Alexander Siemens.

Members of Council Remaining in Office :

E. B. Bright.	H. R. Kempe.
R. E. Crompton.	Prof. A. W. Rücker, F.R.S.
Prof. J. A. Fleming.	Sir D. Salomons.
Prof. George Forbes, F.R S.	Augustus Stroh.

New Members of Council.

Capt. P. Cardew, R.E.	Gisbert Kapp.
Capt. Sir Douglas Galton, F.R.S.	Prof. Perry.

Associate Members of Council.

W. T. Goolden.	W. M. Mordey.	Major M. T. Sale, R E.

Honorary Treasurer :
Edward Graves.

Hon. Auditors :

J. W. Blundell.	F. C. Danvers.

Hon. Solicitors :
Messrs. Wilson, Bristowe, and Carpmael.

The report for 1887 was then read by the secretary, Sir Charles Bright presiding. It was announced that the Council had awarded the Society's prize of £10 to Mr. A. E. Kennelly for his paper on "Faults in Submarine Cables," the Paris prize and the Fahie prize of £5 each being assigned respectively to Mr. Sumpner and Mr. Fleetwood.

Mr. A. C. Cockburn, F.C.S., then read a paper on "Safety Fuses for Electric Light Circuits, and on the Fusing Points of Various Metals Employed in their Construction."

MEETINGS OF SCIENTIFIC SOCIETIES.
(Week ending Thursday, 15th December.)

SATURDAY, December 10th.

PHYSICAL SOCIETY (South Kensington, *3 p.m.*).
1. "Optical Properties of Phenyl-Thiocarbimide." By Mr. H. G. MADAN.
2. "Recalescence of Iron." By Mr. H. TOMLINSON.
3. "Rotation of a Copper Sphere and of Copper Wire Helices when Freely Suspended in a Magnetic Field." By Dr. H. C. SHETTLE.

MONDAY, December 12th.

SOCIETY OF ARTS.
8 p.m. Cantor Lecture.—Series I. "The Elements of Architectural Design." Third part. By Mr. H. H. STATHAM.

TUESDAY, December 13th.

INSTITUTION OF CIVIL ENGINEERS.
8 p.m. Discussion of Mr. Edwd. Hopkinson's Paper on Electrical Tramways.

WEDNESDAY, December 14th.

FINSBURY TECHNICAL COLLEGE.
7:30 p.m. Meeting of Old Students' Association.

SOCIETY OF ARTS.
8 p.m. Ordinary Meeting. "Commercial Education." By Sir PHILIP MAGNUS.

THURSDAY, December 15th.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.
8 p.m. *Conversazione* at the Institute of Painters in Oil Colours, 191, Piccadilly.

ROYAL SOCIETY.
4:30 p.m. Ordinary Meeting.

CHEMICAL SOCIETY.
8 p.m. Meeting.

*** Particulars of meetings to be held or papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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The Electrician.

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THE DISTRIBUTION OF POWER.

A report just published by the Municipality of Geneva on the utilisation of the motive power of the Rhone has attracted some attention in this country by the promise held out of solving one of the most difficult problems of modern industrial life. Switzerland is certainly a favoured land—favoured by the character of its people, by the goodwill of its neighbours, by its unique position in the family of nations, and last, but not least, by the bounty of Nature. The political institutions of this federal republic provoke neither envy nor apprehension; and the way in which she has turned to account her geographical advantages serves only to excite the wonder and admiration of Europe. Perhaps it would be well if she induced in us a greater spirit of emulation, for although we cannot transfer the swift-flowing Rhone to the bed of the Thames or the Mersey, any more than we can legislate by popular acclamation as they do in the Cantons, it is quite possible for us to copy in some degree the excellent example of the Geneva authorities in their solicitude for the welfare of the Swiss artisan. Their aims are set forth in the concluding portion of the report to which we have referred above:—"We believe," say the Municipality, "that we must endeavour to put cheap motive power within the reach of all, workmen as well as employers, if not as a complete remedy for the prevailing social crisis, at all events as a means of lessening its social dangers. For when power from a central source can be obtained in every house as easily as light and water are now obtained, one part at least of the problem will be solved by the workman becoming his own master."

The scheme which is being developed with this lofty purpose has already been at work for some years on a limited scale, and has proved thoroughly successful from a financial point of view. By combining their water supply with other requirements of the town, using for this purpose the inexhaustible power of the famous river on which Geneva stands, the Council have already found that they are able to pay not only the interest on the original outlay, but to cover the sinking fund. Possibly this fact may account for the high moral key in which the report is pitched. Municipalities which have hard work to make both ends meet do not usually add to their troubles by discussing social problems. Geneva, however, is exceptional apparently, not merely in its splendid natural resources, but in the enlightenment of its head men. But for their foresight, courage and wise direction the

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utilisation of the water power of the Rhone on a greater scale, undertaken only a short time ago, would never have been attempted; and they are entitled to all the credit which they claim in the report now before us. Already by means of turbines and pumps the Rhone water is distributed, not only in Geneva, but to a considerable number of outlying communities. A great deal of this is used for the supply of mechanical energy in quantities varying from half horse-power to seventy horse-power, working no fewer than 175 motors within a radius of a mile and a quarter from the central station; and many of these motors are in the homes or workshops of the artisans themselves. It is this latter circumstance which affords the Municipality the greatest satisfaction, the report stating that the success of the scheme is due to the fact that the power has been carried to the worker instead of requiring him to come to the power, or, in other words, to aggregate the workers into a few large factories, with all the evil consequences, moral and physical, which attend the factory life.

Be this as it may the fresh extension of the works now proposed is the result of a rapidly increasing demand for the distribution of mechanical power; and the Council have under their consideration the expediency of introducing electrical transmission in conjunction with the hydraulic power hitherto employed. It is found that in the case of many workshops, chiefly of clock and watch makers, situated in the upper stories of buildings, there will be a saving by adopting electricity. We entertain no doubt that when once the electrical method is fairly at work it will in very many more instances than the Geneva Municipality seem to imagine prove superior in economy to the methods now employed. The Rhone is the most rapid river in Europe, and being swelled by a number of mountain streams just above the city, it offers a striking example of natural water power capable of being easily utilised. The idea of enlisting this mighty force in the service of electricity has arisen through the desire to illuminate the Geneva Theatre with the electric light. From this point of departure a further development is already contemplated; and a Municipality which has shown its business capacity in other directions is not likely to let slip the opportunity which such an installation will afford for extending its mechanical utility.

The question here naturally arises, could not something of the same kind be done for many of the industries of this country? We immediately think of what Spitalfields was and what Clerkenwell is. Scattered all over the United Kingdom are colonies of industrial communities, some of them quite as large as the area served by the Rhone turbines at Geneva; and it may be confidently predicted that many more would be created and grow apace if the requisite motive power at present chiefly concentrated in gigantic factories could be doled out to the operatives at their own homes. Here is a vision to gladden the heart of the social reformer, and could it be realised even to an extent that would stop a long way short of revolutionising the manufacturing industries of this country, it would go far to fulfil expectations such as those which are inspiring the Geneva Municipality in their praiseworthy efforts to ameliorate the condition of the working classes. We have no power-giving rivers to match the Rhone; but we have a far more abundant supply of fuel, and with this at our command a number of central stations for the distribution of electrical energy is by no means an outlandish suggestion, provided the users could be found in sufficient numbers to pay for the outlay. Electrical engineers are not expected to become philanthropists, and they cannot afford, like Municipalities, either at Geneva or Birmingham, to count on the exceeding great reward which the approving voice of Europe may bestow on them. But if in casting about them for fresh fields in which to employ the idle energies of electric lighting installations this one of the distribution of power were always kept in view, probably the search would not long be altogether barren. In America this has already been accomplished to an extent which is not accounted for by the differing circumstances of the two countries. Probably not a tenth of the number of motors which America can boast of have any existence in this country; yet America has introduced them without the least idea of solving any social problems, but on purely business principles. It seems to us that, though we cannot compete with the City Fathers of Geneva, we might emulate at least the electrical engineers of America.

A NOTE ON MOTOR-GENERATORS.

BY ALBION T. SNELL.

The increased demand for the distribution of electricity over large areas, and the evident inapplicability of a low tension parallel system to fulfil the commercial conditions of interest on the capital invested, has led to many ingenious modifications of the elementary system of distribution. At a first glance it is seen that any method to be successful must, broadly speaking, comprise a high tension distribution in the mains and a low tension one in the submains.

As one would expect, the earliest attempts to solve this problem were made with alternating currents. The general properties of alternating currents have been understood for some time, and induced or secondary currents have been utilised for various purposes. The alternating transformer is in fact a development of the Ruhmkorff coil. There is something very fascinating about such transformers, both to the engineer and to the scientist. The absence of moving parts, the simplicity of construction, and the closed magnetic circuit, with the consequent high magnetic induction, are all in favour of this interesting converter of energy—we cannot say machine. There are, of course, certain drawbacks even in these, apparently, simplest of converters. Alternating transformers, although approximately self-regulating when coupled in parallel, are very uncanny things when in series, and as yet they do not seem to have met with much success when supplied with constant current. And, moreover, since the secondary circuit has an alternating current they cannot be used directly for charging accumulators, nor without special precautions for running electric motors, as now designed. These two obstacles are, perhaps, not insurmountable. Alternating currents can be commutated, it is well known, but there seems to be no really commercial method of doing this at present. No doubt, when there is sufficient demand, the problem will be solved in a satisfactory way. Alternating motors, too, which are both self-starting and independent of the phase of the current are not by any means impossible.

But another method of solving the distribution of electricity, without abandoning the use of continuous currents, has lately attracted much attention.

Before criticising these continuous current transformers, or motor-generators as they are more briefly called, it will be well to refer to them by name. During the last few weeks articles have appeared in the columns of this journal on the "Paris and Scott Motor-Generator," the "Edison System of Continuous Current Transformers," and, more recently, on the "Jehl and Rupp Transformer," which is also continuous.

The Paris and Scott motor generator is really a motor with two windings on the armature, each winding having its own commutator and brushes. The field is excited by a shunt from the secondary or dynamo part of the armature. Since the object aimed at is constant potential on the secondary terminals, we may assume the field to be excited by a constant current, and therefore, neglecting the disturbing influences of

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the armature, a constant number of lines of force is supplied to the circuit. The variables then are the currents in both the primary and the secondary circuits, and if the E.M.F. of supply be constant it would appear that the desired condition of constant E.M.F. at the secondary terminals with varying load is obtained. That this is practically so the writer knows from experience, having had the opportunity of testing the machine at the Newcastle Exhibition.

And it is probable that a number of these transformers in parallel, supplied at constant potential, would give very satisfactory results. But when supplied with constant current the difficulties are increased. Assuming the machine to be constructed as now, and the field to be constant, the primary E.M.F. would have to vary directly as the secondary current. This would appear to be impossible. The strength of the field must be varied as in a constant current dynamo. The difficulties to be met with here are well known, and need not be discussed. Suffice it to say the machine lends itself to a constant potential distribution, but, as far as the writer sees, requires considerable modification before it would be adapted for working a constant current circuit.

The Edison system differs essentially from the Paris and Scott in the respect that only the commutator revolves, and the armature coils are coupled direct to stationary brushes. There is an apparent simplification in thus keeping the armature and brushes at rest; but since an independent source of power has to be found for rotating the commutator, the gain seems doubtful. It is not necessary to refer to the structural details of these transformers, which are already familiar to your readers. It will only be necessary to say that all the difficulties pointed out in the Paris and Scott transformer are also found here. They will give constant potential with varying load if supplied at constant E.M.F.; but a self-regulating series system is as far off as ever. In fact, such a transformer requires an automatic governor for varying the number of lines of force generated in each coil in direct proportion to the load. This is a very pretty problem. Edison has also a "rotation transformer." In this the armature has two separate sets of windings, commutators and brushes. The whole is surrounded by a stationary ring of laminated iron, which serves to lower the magnetic resistance and concentrate the field. The weakest part of this arrangement is that it requires to be driven by an independent motor.

The Jehl and Rupp system shows much originality, and is evidently the outcome of a good deal of experimental work. Several types of alternating and continuous transformers are described, but it is only intended here to refer to the latest motor generators. These transformers are broadly divided into two classes, one for parallel distribution, the other for series. It is worthy of note that this is perhaps the first successful attempt to run constant current transformers. In all the latest types the motor generator itself is stationary, and the commutator only is rotated. This resembles the Edison system so far. The chief difference is found in the arrrangement of the coils. Both wind the primary and secondary circuits on separate cores; but Edison further subdivides the several coils of each circuit on different cores, while Jehl and Rupp are content with one core for the primary and one for the secondary. Since the theoretical conditions are identical, the better plan can only be decided by time, the questions of cost of production and efficiency of running being the most important factors.

The distribution commutator is somewhat complicated, but care has evidently been taken to reduce to a minimum the risks of breakdowns. And here, again, comes one of the weak points of motor-generators—the motor to rotate the commutator. Of course the motor has very little work to do; but yet another link is added to the already long chain. A parallel distribution by this means would be self-regulating if the resistance of the secondary circuit was sufficiently low. Only one distribution commutator is necessary for each centre or group of transformers, for all the rings are coupled to the same distributor, there being as many wires from each as there are coils.

Jehl and Rupp have also another practical form adapted for constant potential circuits in which the distributer is not used. In this the primary and secondary circuits are wound on separate iron cores, the one a ring and the other a drum. The ring is fitted securely outside of the drum, and the whole is surrounded by a laminated iron ring. The windings are coupled to separate collectors on a shaft passing through the centre of the drum. The brushes are stationary. The whole machine is rotated by a motor. Since the brushes alone are at rest, it follows that the axis of magnetism will remain fixed with reference to space if we neglect the vibrations due to the reversals of current in the coils immediately in contact with the brushes. The position of the brushes is a matter of no importance, and there should be no sparking. The transformer would regulate if supplied at constant potential, if the speed of rotation did not vary and the internal resistance were low. If a motor generator of this type were supplied at constant current, and were rotated by an ordinary series-wound motor, it would not give constant potential on the secondary terminals. For running in series Jehl and Rupp provide another form of the apparatus. This type is remarkable, as it only has one winding. In its simplest form a Gramme ring is surrounded by a laminated iron ring, and is mounted on a shaft carrying a collector. The whole is rotated by a motor driven by the main current. The brushes are stationary. The lamp circuit is a shunt to the transformer terminals. If the lamp circuit be open the whole of the main current will pass through the motor-generator. When it is closed the current divides between the two circuits in proportion to the resistances. The lamp circuit will take maximum current when the motor-generator is running at its greatest speed. The regulation for constant potential on the terminals can thus be secured by varying the speed of the driving motor. This is done by means of an electrical governor, which varies a shunt to the series-motor in the main circuit. Another method practised by the inventors is to put a variable shunt to the lamp terminals. The desideratum of regulation is simply that the back E.M.F. equals the potential required for the lamp service plus the number of volts lost over the internal resistance of the transformer.

In another form of these series motor-generators the commutator only revolves, as in the constant potential types. The method of supply and regulation is the same as in the other. The disadvantage, other than the independent driving motor and the moving part, is that the energy absorbed appears to be practically the same whether the transformer is running light or with full load. This is a very serious drawback, and, if correct, will prohibit the extensive use of the apparatus. The writer believes this to be the only attempt at running continuous current transformers in series. That the object sought is obtained there appears to be no doubt, though the multiplicity of parts and the constant rate at which energy is consumed for a variable useful effect do much to militate against the system. MM. Jehl and Rupp, however, are to be congratulated on their present success, but no doubt some less complex method of solving the problem will follow shortly.

Reviewing, then, what has been accomplished with continuous current generators, and bearing in mind the object of this inquiry, the applicability of such machines to a method of general distribution, the writer does not feel that the problem is much nearer solution. It will be noted that, with one exception, these transformers do not readily lend themselves to a constant current distribution, and the exception has a poor commercial efficiency if the output demanded be a variable one. Again, all of these systems have moving parts, and two require independent motors for rotating a portion or the whole of the apparatus. This is an objection which only becomes serious when it is proposed to employ the apparatus under circumstances where little or no skilled attention can be given; but, generally speaking, that system which has the fewest moving parts is the most likely to give the best average results, and the more so when it is borne in mind that the risks of breakdowns from defective or damaged insulation must always be greater with moving than stationary coils. More attention, at any rate, is likely to be entailed by these transformers than with alternating ones, which have no moving parts.

The strong point of the motor-generator is the direct secon-

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dary current. It can be used for charging accumulators, and for driving ordinary motors. This alone is enough to ensure a large field of usefulness for the apparatus. Another important difference between the two types is found in the efficiency of conversion. From the very nature of things the motor-generator cannot be so efficient as the alternating generator. From the data already existing, the efficiency of an alternating transformer averages about 95 per cent.; the Paris and Scott motor-generator, judged by the Newcastle tests, only gives a return of about 86 per cent. A difference of 9 per cent., although, perhaps, a small matter in an isolated installation, must be a very important one in a system of general distribution.

The conclusion may be roughly stated thus:—Continuous and alternating transformers are equally adapted for parallel distribution, and they both, perhaps, are on much the same footing as regards a series system. Alternating transformers are superior in the respect that they have no moving parts, and have a higher efficiency of conversion. Motor-generators have the advantage of giving a direct current in the secondary circuits. How long this apparent balance will be maintained is a matter of speculation. It may, however, be taken as an axiom that either system, to come into general use, must have a high tension (probably a series) primary distribution and a parallel secondary.

ON SOME INSTRUMENTS FOR THE MEASUREMENT OF ELECTROMOTIVE FORCE AND ELECTRICAL POWER.*

By J. A. Fleming, M.A., D.Sc., and C. H. Gimingham.

These instruments do not present any novelty of principle. They differ from that form of instrument generally called an electro-dynamometer in the arrangement of details, but they

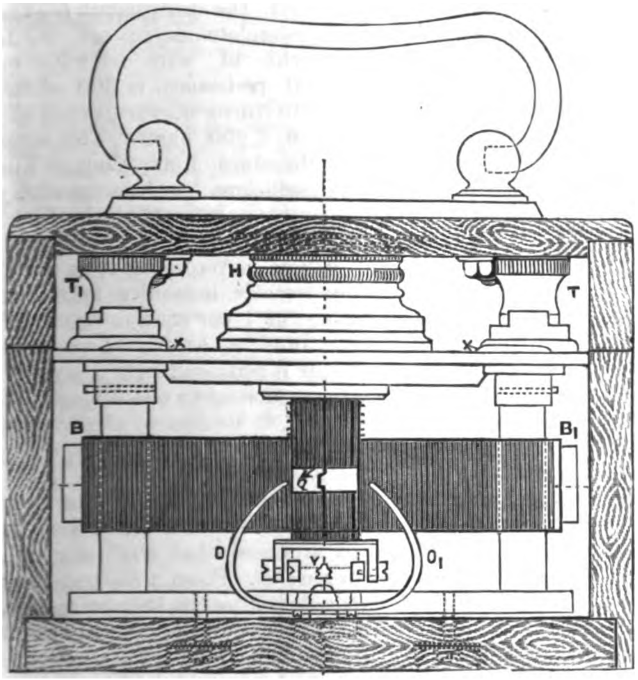

Fig. 1.

depend for their operation upon the electro-dynamic action of currents in fixed and movable conductors. Our object has been to furnish an electro-dynamometer which shall be portable, compact, and require in its use no mercury cups, tables of square roots, nor multiplying factor, nor any reference other than to the scale of the instrument, in order that electromotive force and power may be determined by it at once. Our experience in the use and testing of voltmeters of nearly every kind has been such as to lead us to look doubtfully at any instrument which either contains soft iron, permanent or electro magnets, or in any way depends for its action on the behaviour of iron when placed in varying or successively varied magnetic fields. No matter how treated, a piece of soft iron has a "magnetic memory." Unless rapid magnetic reversals, aided by rise of temperature, are brought to bear upon it, it is very difficult to eliminate from it the results of its previous magnetic history and to bring it back into the condition in which its magnetisation is the result, purely and simply, of the present magnetic force brought to bear on it.

* A paper read before the Society of Telegraph-Engineers and Electricians, November 25th, 1887.

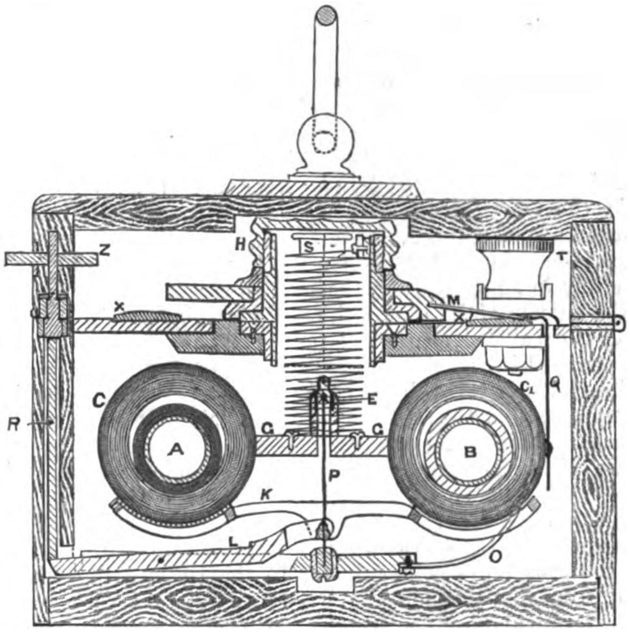

Fig. 2.

We start, therefore, with the principle now adopted by Sir W. Thomson, that in thoroughly satisfactory electric-measuring instruments the magnetisation of iron must not be permitted to play any part in the design. In these instruments we submit to

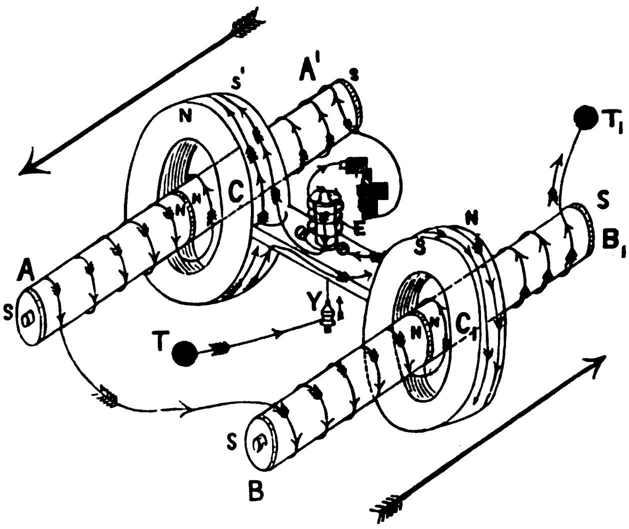

Fig. 3.

the criticism of the society the action is wholly based on the fact that when conductors conveying electric currents are arranged so that one of them is fixed and the other free to move, the force required to hold the movable conductor in any given position in the field of the fixed conductor is proportional to the product of the strengths of the current flowing in these conductors respectively. The general arrangement of the high resistance dynamometer or voltmeter is shown in Figs. 1 and 2, which show cross sections of the voltmeter. The general design of the instrument is as follows:—A A^1

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B B[1] (Fig. 3) are two solenoids of insulated wire (German silver) wound on brass tubes. The solenoids are wound so as to have a magnetic pole in the centre of each, marked N N. The ends of the solenoids are therefore similar poles, S. Two such solenoids are held in a frame, and fixed so as to be parallel to each other. The general arrangement of the voltmeter free from detail is shown in Fig. 3.

These fixed coils are embraced by two annular coils, C C[1], which are wound on exceedingly light metal frames, and are carried on the ends of an ivory bar, G G (Fig. 2). The resistance of the fixed coils may be about 1,000 to 1,500 ohms, and the resistance of the annular coils about 500 to 1,000 ohms. This ivory bar carries at its centre a glass-hard steel cup, by which it is supported, so as to move freely, like a compass needle, on a steel iridium-tipped needle, P. The coils are very accurately balanced, and, whilst embracing the fixed coils, have yet clearance enough to permit them to swing through a small angle on either side. Their range of movement is, however, limited by two stops, O O[1] (Fig. 1).

To the ivory cross bar carrying these movable coils is attached a steel spiral chronometer spring, the upper end of which is held in a tubular collar, H (Fig. 1), capable of revolving stiffly in an aperture in the dial plate. This collar carries on the outside of it a mica-tipped index finger. The index finger is capable of being set round on the tubular collar H, and clamped in any position.

The inside of this tubular collar has an attachment by which the upper end of the steel spring can be taken up more or less, just as the hair-spring of a watch is set.

The electrical connections of the voltmeter are shown in Fig. 3. It will be seen that the current enters from one terminal, T[1], passes thence to the top of the spring, then down the spring into the movable coils C C[1], from there to the steel cup E, through the contact point to the iridium-tipped steel pivot, from that through the fixed coils and so back to the other terminal T. The windings of the movable coil are so arranged that it is astatic, and not influenced by a vertical or horizontal uniform field. This is important in an instrument to be used in the neighbourhood of powerful magnets.

The movable coils carry a light aluminium needle Q which projects up through a slit in the dial plate, opposite to the zero of the scale.

The whole instrument is contained in a small wooden box, about 4½in. square by 3in. deep. On opening the box a dial plate is seen having a circular scale divided so that the volt readings are obtained without any calculations. The operation of taking a reading is as follows:—The box is first levelled on the table by means of a wooden wedge provided for the purpose. The central hollow boss is first turned until the mica index finger is at the zero of the scale. The aluminium index, carried by the movable coils which project up through a slit in the dial, should also be opposite the zero. If this is not the case the mica index finger has to be shifted. This is accomplished by slacking up the milled head on the top of the central boss and readjusting the index until the mica index finger and the aluminium index of the movable coils both stand opposite to each other at the zero. The current is now passed, and the electromagnetic action causes the movable annular coils to be shifted along the fixed coils, displacing the aluminium index. The central boss, carrying the upper end of the spring, is then turned until a torsional force is brought to bear on the movable coils, bringing them back against the electromagnetic forces into the zero position. It will now be found that the upper end of the spring will have been twisted through a certain angle, as indicated by the position of the mica index finger. The value of the current passing through the instrument is proportional to the square root of this twist required to bring back the coils into their zero position, and, as the force brought to bear on the coils is proportional to the angular displacement of the upper end of the spring, it follows that the square root of the angular displacement of the mica index finger required to maintain the movable coils at their zero position is proportional to the strength of the current flowing through the instrument. To avoid any calculations or reference to square-root tables, the dial is graduated in the following manner:—If the instrument is intended to read, say, from 20 to 110 volts, then one complete turn, or 360deg. displacement of the index, is required to balance the electro-magnetic force due to 110 volts on the terminals of the instrument. The angular displacement for x volts is, then, $\frac{360 \times x^2}{(110)^2} = \frac{18}{605} \times x^2$, measured in degrees, and accordingly the positions for all volt values from 20 to 110 can be set off directly on the dial. The index needle is then simply turned until the aluminium index is brought back to zero, and the dial reading gives at once the volts. This form of graduation has the advantage that the scale interval corresponding to one volt is greatest in that part of the scale which will be in each instrument presumably most used.

In order to render the instrument portable, means are provided to raise the movable coils off the point P (Fig. 2) by the action of closing the box. A clutch-bar, K, is so arranged and pivoted that by means of a pin, R, sliding in a hole in the box a pressure on the upper end of this pin raises the coils, C C[1], and relieves the iridium point of the pressure of the movable coil-bar.

It is not desirable that the movable coils should be taken up and let down suddenly on the pivot, and to make this action deliberate the box lid is opened and closed by a screw. The user is thereby compelled to open the box slowly and let down the coils with a gentle motion on to the pivot P.

The voltmeters are constructed to work over various ranges. One type ranges from 20 to 110 volts. By associating a resistance coil with the voltmeter, the resistance of which is equal to that of the voltmeter, the volt values of all the readings become doubled and the instrument becomes available for use between 40 and 220 volts. In order to give a little margin over and above the 110 and 220 volts, the graduation is continued, according to the square-root law, along an outer circle. A little more than one complete twist of the spring enables a reading to be taken up to 115 or 120 volts on the 110-volt instrument, or to 230 or 240 on the 220-volt instrument. In the 110-volt instrument (construction A), the following are the electrical and mechanical data of the instrument:—The weight of the movable coils complete is in all 20·27 grammes. The number of turns of wire is 960 on both coils together, and the total resistance is 300 ohms. The four fixed coils have each 840 turns of wire, or 3,360 turns in all, and a resistance of 1,200 ohms. The total resistance of the voltmeter is therefore 1,500 ohms. The temperature resistance variation coefficient has been carefully determined for a mean temperature between 15deg. and 30deg. C. for the particular kind of German silver wire used, and it is ·0273 per cent. per degree. Accordingly, as far as regards change of temperature as a whole, it requires an alteration of 30deg. C. to make a change of 1 per cent. in the value of the voltmeter readings. To prevent, as far as possible, heating of the coils, each voltmeter is provided with a key. In using the instrument the first operation after opening should be to level it carefully, by inserting, if necessary, the wooden wedge provided under the front or back side until the pointer on the movable coils swings freely from side to side.

We have also constructed, on this type, a wattmeter. In this case the fixed coils (now called the current coils) are wound with thick wire, and so arranged that the four coils can be joined up in series or in parallel. From a separate pair of terminals the current is conducted into the thin wire coils, which are the movable coils, and constructed exactly as for the voltmeter, only with a higher resistance. In using this wattmeter for measuring the power taken up, say, in an incandescent lamp, the lamp should, as usual, be put in series with the thick wire coils R. The fine wire coils r should have their terminals joined, not to the two terminals of the lamp, but to the terminals of the lamp and the thick wire coil as joined in series. The thin wire coil thus measures the potential at the extremities, not of the lamp, but of the lamp and thick wire coil in series. The reason for this is as follows:—Suppose the thick wire coil to have a resistance of ·01 ohm and the thin wire coil to have a resistance of 1,000 ohms, and apply this wattmeter to measure the power consumed in two lamps, each of 8 candle-power and requiring, say, 20 watts—but in one case let the lamp be a 100-volt lamp taking ·2 ampere, and in

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the other a 10-volt lamp taking 2 amperes. If the fine wire coil is joined in parallel with the lamp alone, in the case of the high-volt lamp, since the resistance is 500 ohms hot, the lamp will take two-thirds of the whole current flowing through the thick coil—in other words, the current which flows through the thick coil is not that flowing through the lamp, but that through the combined resistance of lamp and fine wire coil. If, however, the same wattmeter is applied to measure the power of the low-volt lamp, then, since the hot resistance of this is only five ohms, the lamps will get $\frac{1000}{1005}$ths of the current flowing through the thick coil. It follows from this that whereas the two lamps consume exactly the same power, yet, in the first case the current in the thick coils, which is that which actuates and is one of the factors in determining the reading of the wattmeter, is half as great again as it should be. It would be found that in the case of the high-volt lamp the wattmeter reading would be 30 watts, and in the case of the low-volt lamp 20 watts, although both lamps actually take the same power. If, however, the extremities of the voltmeter, or movable or fine wire coils, are joined, as shown in the figure above, then the current in the thick coil is exactly that through the lamp, the error in the electromotive force part of the measurement is then only dependent on the fact that the thick wire coil has an appreciable resistance; if this is only ·01 ohm, the error made in the electromotive force part of the measurement is only ·1 per cent., even in the case of the low-volt lamp, by assuming the potential at the extremities of the lamp and thick coil in series as equal to that at the terminals of the lamp.

Unless the resistance of the current coils is vanishingly small compared with that of the high resistance or movable coils, the above method of joining up the wattmeter does not give the real rate of dissipation of energy in the lamp or other circuit under consideration.

(To be continued.)

DISCUSSION ON MEASURING INSTRUMENTS AT THE SOCIETY OF TELEGRAPH-ENGINEERS

At an adjourned meeting of this society on Thursday evening, December 1st, the discussion on the papers read by Dr. Fleming and Mr. Gimingham and Profs. Ayrton and Perry was resumed. Sir Charles Bright presided, and there was again a good attendance of members.

Mr. ALEXANDER SIEMENS said he was very glad to have had the opportunity of hearing Prof. Fleming's paper, and to see the new form of dynamometer which had been elaborated from the original design of the instrument as made by his firm. He had brought an instrument there which was the latest form in which their own dynamometers were constructed. In using it they employed mercury cups, and they worked perfectly well. The new type was designed especially for use on ship board, where the ordinary type was not very serviceable, and, moreover, it had the great advantage of being direct reading, the indications being proportionate directly to the current. This instrument was due to Mr. Raworth, by whom it was designed at the time when he was in their (Messrs. Siemens) employ. It had no movable contacts, which was an advantage not possessed by Dr. Fleming's instrument. He had the actual instrument there, and would explain the principle. Dr. Fleming mentioned that it would be bad to have iron in the dynamometer. They had overcome his difficulty. They had the cylinder of iron, which was pivoted between two fixed points in the usual manner, to have the friction as small as possible. It carried two iron arms, which were very thin and flat, and at right angles to these arms it carried a pointer the same as in the other dynamometer. At the top was a spring which counteracted the influence of the current. Even with a very small current these two thin iron arms were magnetised to their greatest extent, and they had an instrument which would read from 10 to 320 degrees, and could be used in any position, the moving parts being balanced, and there not being a single loose contact in the instrument. This was a very handy instrument to be used on board ship. In order to avoid getting permanent set in the spring it was always advisable to have a switch, take the reading, and take the instrument again out of circuit. For measuring the volts of an alternating current the instrument brought forward by Prof. Ayrton as an improvement of Captain Cardew's was of course very much better adapted.

[We are indebted to Mr. Siemens for the accompanying drawings of the instrument, together with the following detailed description:—Fig. 1 is a vertical section, Fig. 2 a sectional plan, and Fig. 3 a front view showing the part immediately underneath the dial. The same lettering applies to each figure.

A is an iron spindle delicately pivoted at its ends where there are two iron arms a a projecting from it in opposite directions. Around the spindle A there are conducting coils B consisting, for the electro-dynamometer, as shown in Figs. 1 and 2, of a few convolutions of copper bar of rectangular section helically wound without contact with each other, but in the voltmeter, consisting of numerous convolutions of fine wire. In either case, when the currents traverse these coils, the arms a a constitute polar extensions of the solenoid core A.

As shown in Fig. 1, the current entering by the post C passes along a metallic framing C^1 C^2 C^3 through the coil B and out by the post D or in the reverse direction. In passing along the parts of its circuits C^1 and C^3, which are parallel to the arms a a, it tends to deflect them and so to turn the spindle A partly round, with more or less force according to the strength of the current.

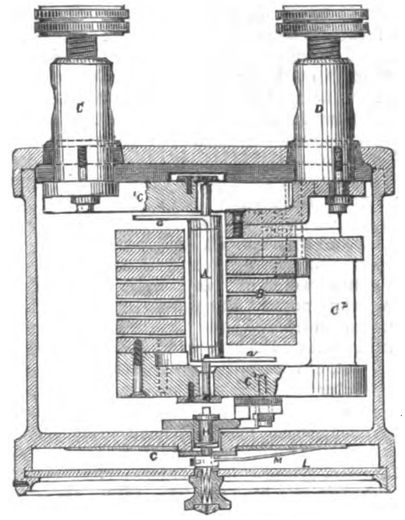

FIG. 1.

At the front end of the spindle A is fixed a light index wire F, which may be of aluminium. It is counterbalanced by an adjustable weight F^1 and is bent forward so as to project through a hole in a dial G. Through this dial passes a central spindle H, which can be turned by hand and which

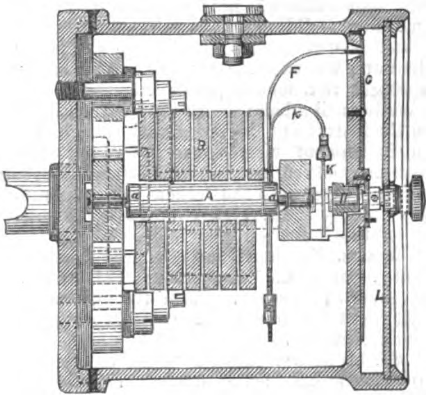

FIG 2

has fixed to its inner end the innermost convolution of a volute spring, K, Fig. 3, the outermost convolution of which is connected by an arm, k, to the index wire F. On the spindle H, outside the dial G, and protected by a glass, L, there is fixed an index, M, pointing to graduations on the dial.

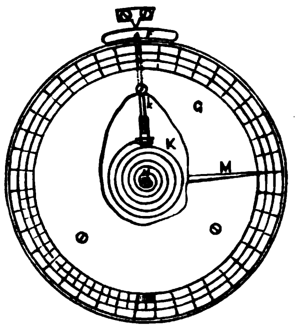

FIG. 3.

When the instrument is put in circuit, the spindle H is turned by hand until the force of the volute spring K is made to balance the force tending to turn the spindle A by deflecting the arms a a, as can be seen by observing the point of the wire F just vibrating within the hole of the dial through which it passes. The reading is then taken direct from the dial, no separate table of values being required.]

Mr. GORDON said he thought it opportune to bring to the notice of the society an instrument which was manufactured in Germany and had not been much seen in England. Mr. Gordon then described Dr. Aron's well-known current meter. He brought it forward, he said, because it was now in a practical form for actual use. As they were dealing with the scientific aspect of the question they must remember that the principle belonged to Profs. Ayrton and Perry. In fact, he thought he might go so far as to say that the makers had offered to recognise the share which Profs. Ayrton and Perry had taken in its original design. He (Mr. Gordon) had not tried the

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meter himself, but Mr. Frumpet said he had found it extremely accurate and extremely practical.

Captain CARDEW having made a few observations on a small portable voltmeter which he introduced as a curiosity,

Mr. ESSON said, speaking as a maker and user of electrical measuring instruments, he could not see that the form of instrument introduced by Dr. Fleming possessed any advantage over several forms already before the public and in the market. All that Dr. Fleming's voltmeter was capable of doing could be performed by a finely-wound Siemens dynamometer, and that without taking the current through the spring, which was, he thought, decidedly objectionable. They knew that the elasticity of springs remained under ordinary conditions very constant for long periods, but it was doubtful whether in the present instance the value of the constant would not be altered by the continuous heating and cooling, or expansion and contraction due to the currents flowing through the spring. He presumed Dr. Fleming meant his instrument to be used only as a standard and not for installation work. For the latter they required indicating instruments, which would show from moment to moment the E.M.F. or current flowing. Zero instruments, in which, before an observation was made, the movable part had to be balanced by the observer, were quite unsuitable for installation work. As regarded wattmeters, he greatly doubted whether the profits to be derived from their sale compensated for the trouble of designing them. Out of some thousands of instruments sold by his firm they had only managed to dispose of some half-dozen wattmeters. It seemed to him that these instruments were of very little use. People not only required to know the power expended in the circuit, but also how the product of amperes and volts was made up. Dr. Fleming truly said that that could be obtained by a wattmeter and voltmeter, but, of course, it could be equally well obtained from an ammeter and voltmeter. Mr. Esson then described one that measured 2,500 amperes, and was designed by Sir William Thomson. It consisted of a movable ring, supported above a fixed ring, the former being suspended by two ligaments, each consisting of 900 copper wires, one-tenth of a millimetre diameter, lying side by side. The bottom ends of the ligaments were attached to two pins projecting from the sides of the movable ring towards its interior, the top ends to two pins fixed above those. The current divided on the movable ring, half going round each side, while on the fixed ring it circulated in one direction only. There was, consequently, attraction between the fixed and movable rings on one side from parallel currents, and repulsion on the other side from currents in opposite directions. The force tending to tilt the movable ring was balanced by a sliding weight, its position indicating the current flowing. The instrument was a very difficult one to use. When the scale beam was nearly balanced the slightest pull on the cord which moved the sliding weight was sufficient to make the beam kick dreadfully, and it was almost hopeless to attempt balancing the current unless the latter was extremely steady. As a matter of fact, they had to move the weight to a definite position, and reduce or increase the current very gradually until a balance was obtained, noting at that instant the deflection on the instrument in series with it, which is being calibrated. A spring instrument, where the force was put on very gradually, was much easier to use; but springs, on the other hand, might lack the constancy of weights. Coming to the Cardew voltmeter and the ingenious modification introduced by Profs. Ayrton and Perry, he noticed several of the latest forms of the former on the table. In the particular instrument made by Messrs. Paterson and Cooper there were expended about forty watts, and the temperature of the tube rose to about 150deg. F., he should think. From the figures given to him by Prof. Ayrton last week he found the watts expended in his instrument about the same; but from the fact that with his the radiating surface was very small, he should think it would rise to a very high temperature. The question would then arise whether the heating and cooling would not affect the permanency of the springs. Prof. Ayrton said that a certain initial sag had to be given to the wire. He should like to know what adjustment there was for ensuring that the sag would be the same when the instrument was re-wired. In an instrument constructed on the Cardew principle it was most important that the least difficulty be experienced in re-wiring should the wire break or fuse. In the form made by his firm, the wiring was most simple. Though he had never re-wired an instrument, he never considered it a very formidable task until he saw Prof. Ayrton's. His instrument he thought must be very difficult to wire. Probably the best way to determine whether the new or the old form were the easier would be to have a race. Prof. Ayrton would start re-wiring his and he (Mr. Esson) his, and the one who finished first would be the winner (laughter.)

Mr. EVERSHED said like every one else he was very much delighted with the appearance of Dr. Fleming's instrument. Everyone had said something about the spring. He should certainly prefer an instrument if the current were not led through the spring. No one had said anything about the temperature errors of springs. He had not had much experience of them, but he suspected they had a kind of temperature coefficient. He should very much like to know whether they had, or whether they were simply spoiled by rise in temperature. He was rather surprised that Dr. Fleming should have used platinoid in one of his instruments, for so far as his experience went if they wound an instrument of that type with copper and put platinoid in series with it, they expended less power than if they wound with platinoid. Of course then there was the error after heating, but that could be compensated by the method devised by Mr. Swinburne, and communicated by him to the British Association at Manchester. Dr. Fleming's instrument could be easily compensated. As to the wattmeter, he did not agree with Mr. Esson about the uses of wattmeters. Of course he was speaking of those used in engine works. His (Mr. Evershed's) experience had been in lamp factories, and Dr, Fleming's was intended for use in the lamp factory. For many months he used a roughly-made direct-reading instrument, not zero reading, and he calibrated that in candles. A girl about 14 tested an enormous number of lamps by that wattmeter. She conducted the operation most happily, and was singing hymns all day (laughter). With this particular instrument before them she might have got through a great many, but he did not think she would have sung the hymns (renewed laughter). He had intended saying something about the compensation of instruments in general. The subject was brought to the notice of the public by Mr. Swinburne, at Manchester, and he had been working at it practically for some time. His instrument was not ready yet, but he hoped early next year to be able to bring it before the society. Coming to Profs. Ayrton and Perry's low-reading voltmeter, it seemed to him admirably adapted for testing secondary cells. There was a distinct want of instruments reading up to 5 volts; they had not been able to bring out a satisfactory instrument, although many experiments had been tried. Profs. Ayrton and Perry seemed to have objections to gearing. If they wanted an instrument that could be knocked about by an engine driver, the Cardew voltmeters they saw on the table were thorough engineers' instruments. They were solidly made, and the use of gearing enabled them to do away with the objectionable silk passing round the axle. It was very difficult to get good gearing, but the perfect curves which they got from this instrument showed that the rate at which the pinions turn exactly corresponds to the rate of the wheel. Mr. Esson said something about the power spent, but he must have been simply thinking of the spring. He had already asked Dr. Fleming about the effect of temperature on the springs. There was another point which occurred to him. In the small instrument, reading up to 10 volts, the loss appears to be very small. He thought it worked out at not more than 2 watts. In the instrument reading up to 170 volts the power spent was something like 50 watts. In their instrument they found that a radiating surface of about 5 to 7 square meters would do for a watt, and they got quite enough heat at that. He was quite sure they could not leave the new instrument "on" at 170 volts. One of the charms of the Cardew instrument to him was that they *could* leave it on. He had come across a very interesting point in making Cardew voltmeters with respect to the energy of radiating by fine wires and thick wires. If they had a given length of wires of different thicknesses and passed the current through you raise them to the same temperature, taking the deflection on the dial as indications of the temperature. They did not know what the temperature was, but they knew it was the same temperature if they had the same deflection, provided the position of the wires be the same It might have been expected that it would take less power to keep the fine wire at the temperature than it did the thick; but he found it did not. In the first experiment the fine wire positively took more power. He repeated the experiment more carefully. He had taken one volt, and used strains proportional to the breaking weights of the wires. The different sizes of the wire were 1·5, 2·5, 3·5. The wire was in the same position on each occasion, and he raised it to 280 degrees deflection, which he knew corresponded roughly to 200 degrees centigrade, and the indications were 1·4—38·2, 2·5—36·9, 3·5—32·2. He would not at the present time say these figures were exactly right, because one did not know the exact position of the wire, and it was absolutely essential to know that; but it was quite clear that the power did not diminish as the size of the wire diminished.

(This Discussion will be concluded in our next.)

THE COST OF CENTRAL STATION LIGHTING.

A valuable and interesting article under the above title appeared in *Industries* of December 2nd. The article is too long for reproduction in our columns, but we would recommend every electrical engineer to make a point of reading it. Meanwhile we present the following summary of its contents:—

The writer proposes to institute a general comparison between the cost of lighting from central stations on the three systems which admit of distribution by means of high tension in the mains with low tension on the supply circuits. In these systems the necessary transformation may be effected—(A) by storage batteries, (B) by rotary transformers, (C) by alternating current transformers. After a preliminary discussion of the particular advantages and disadvantages of the several systems (matters which are, however, within the cognizance of every electrician), the writer proceeds to compare their relative economy in a given case, "taking as an example a central station plant capable of maintaining 10,000 glow lamps of 60 watts each, simultaneously alight, a capacity which will probably suffice for a total of 15,000 lamps fixed." The other working data are taken as follows:—

Annual hours of burning	1,500
= Total lamp hours per diem	60,000
= Board of Trade units per diem	3,600
Maximum rate of supply	600 kilo-watts.
Distance from charging station to centre of district	2 miles.

(A) BATTERY SYSTEM.

Total storage of batteries	4,000 units.
Maximum output	1,000 kilo-watts.

The margin is considered necessary for safety.

It is assumed that each sub-station supplies 2,000 to 3,000 lamps.

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(A) Storage Batteries in Sub-Stations.

Total storage capacity required	4,000 units.
Maximum output required	1,000 kilo-watts.
The battery is preferably divided into two unequal sets of cells for day and night service respectively.	
Output of smaller battery	350 kilo-watts.
,, larger battery	650 kilo-watts.
Efficiency of batteries, including regulating appliances	75 per cent.
Charging current for larger set	160 amperes.
Under an E.M.F. of	2,000 volts.
Charging period	10 hours.
Loss of energy allowed in charging mains	10 per cent.
Maximum output of dynamos	355 kilo-watts.
Add 20 per cent. of reserve dynamo power	430 kilo-watts.
Necessary steam plant	700 I.-H.-P.

Cost—

Cells at £30 per kilo-watt maximum output	£30,000	
Supply mains at £1 per lamp	15,000	
Dynamos at £8 per kilo-watt	3,440	
Engine and boilers (including foundations, shafting, and all accessories) at £12 per I.-H.-P.	8,400	
Charging mains, exclusive of attachments (allowing for loss of 200 volts)	1,600	
Regulating appliances at sub-stations	1,000	
		£59,440

or, say, £60,000, which is at the rate of £4 per lamp fixed.

(B) Rotary Transformers in Sub-Stations.

Commercial efficiency of transformers	85 per cent.
Maximum rate of supplying energy on primary circuit	700 kilo-watts.
Loss of energy allowed in primary circuit	10 per cent.
Output of dynamos	775 kilo-watts.
At 2,200 volts this gives current in circuit	350 amperes.
Adding to output 20 per cent. reserve power	930 watts.
Necessary steam plant	1,500 I.-H.-P.

Cost—

Transformers at £10 per kilo-watt	£7,200	
Dynamos at £8 p r kilo-watt	7,440	
Steam plant at £12 per I.-H.-P.	18,000	
Feeding mains for 350 amperes, exclusive of attachments	3,300	
Supply mains at £1 per lamp	15,000	
Regulating appliances	500	
		£51,440

or, say, £52,000, which is at the rate of nearly £3. 10s. per lamp.

(C) Alternate Current Transformers on Consumer's Premises.

In this case, as every consumer must be supplied with a transformer capable of feeding the whole of his lamps at once, the transformer plant must be equal to an output of 15,000 lamps instead of 10,000, as in (A) and (B). The dynamos, however, need have only the same output as before.

Average number of lights per transformer taken at	100.
Number of transformers required	150.
Total maximum output of transformers	900 kilo-watts.
Efficiency	93 per cent.
Maximum rate of supplying energy on primary circuits	645 kilo-watts.
Loss of energy allowed in primary circuit	10 per cent.
Output of dynamos	720 kilo-watts.
Adding 20 per cent. reserve power	865
Efficiency of dynamos, including 3 per cent. of output required for exciters	80 per cent.
Steam power required	1,450 I.-H.-P.

Cost—

Transformers at £4. 10s. per kilo-watt	£4,050	
Alternate current dynamos at £6 per kilo-watt	5,190	
Exciters	350	
Steam plant at £12 per I.-H.-P.	17,400	
Feeding mains (as in B)	3,300	
Regulating appliances (as in B)	500	
House connections	600	
		£31,390

say £32,000, which is at the rate of a little under £2. 3s. per lamp fixed.

The article concludes as follows :—" A glance at these figures will show the enormous superiority in point of capital expenditure which the alternating current system has over its two rivals. In making the above estimates we have, as stated in the beginning of this article, left out of consideration the question of motive power, because in the immediate future this branch of the business need hardly be taken into account. The use of electricity for lighting must always precede its general application for motive-power purposes, and it would be unwise to allow the latter to play too important a part when deciding upon the system to be adopted. If, however, motive power were taken into consideration, then rotary transformers would offer a distinct advantage over batteries, inasmuch as their capacity need not be increased on this account. Motive power will be principally required during the day and light during the evening, so that without a further increase in the cost of the central station or that of the transforming plant, a considerable call for motive power could be met. With the batteries this is not so. We have estimated for a capacity just sufficient for lighting purposes only, and if motive power is to be supplied during the day, larger batteries would have to be installed. The alternating system, on the other hand, may at present be said to be quite unfit for the supply of motive power. Experiments have been made with a view to develop motors driven by alternating currents ; but up to the present the results obtained are not of such a nature as to justify any electrician to include the supply of motive power in his scheme when laying out a central station on the alternating-current system. That ultimately the difficulty of obtaining motive power from alternating currents will be overcome by the invention of a suitable motor may reasonably be expected, and if this result is achieved the superiority of the alternating system over either battery or rotary transformer will be still further enhanced. As matters are at present, we may sum up the foregoing by stating that the expenditure for plant is about equal, whether secondary batteries or rotary transformers are used, and that it is little more than half when alternating currents and transformers are employed."

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, Nov. 24th, 1887.

The endeavours now being made in England to form an association which will deal in a representative way with the commercial interests of electrical engineering are watched with no small interest in this country. The work of such an association would, it appears, be confined chiefly to the department of electric light and electric power, and hence it would closely resemble the American National Electric Light Association, to which reference has so frequently been made during the discussion of the subject. It is to be borne in mind that the American body is very largely composed of the representatives of local electric lighting companies of all the various systems, except the Edison, which has an association of its own. The National Electric Light Association does not indulge in scientific discussions—these are, in fact, forbidden by its constitution—but twice a year it brings a very large amount of experience, common sense, and business ability to bear on the practical details of an industry growing more rapidly than any other, perhaps, in this country. Under the brilliant and energetic direction of its president, Mr. J. F. Morrison, of Baltimore, the Association has done good work, and although the lines of its future action cannot yet be said to be determined it will undoubtedly find with the expansion of the business enlarged opportunities of usefulness, and will live up to them. The visits of the body to various parts of the country for its semi-annual meetings have been of immense benefit in arresting popular attention to the vitality and prosperity of the industry, and have given marked stimulus in each place to the use of electricity for all purposes.

With the approach of winter the number of English visitors is notably reduced. One of the latest to remain is Mr. M. Holroyd Smith, whose work at Blackpool is so well known and was so recently celebrated with unusual honours. Next week Mr. Smith is to give the New York Electrical Society a "Talk on Tramways," and the occasion will no doubt be one of much interest and profit to the members.

The Electrical Exhibition which has been given in this city under the auspices of the Society draws to its close. It has been in many respects a marked success. Nothing of the kind had ever been attempted before in New York, and despite the extensive use of telegraph, telephone, and electric light here, the ideas of the general public on the subject of electricity

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have been very vague and crude. The society can justly claim to have done some excellent educational work this autumn, and there will be many appreciable results. A special and very prominent feature of the Exhibition has been the motor display, which has included illustrations of the uses of electricity as a motive power in well nigh every department of industry dependent on machinery. The attendance throughout has been good and of a high character.

A noteworthy feature in cabling was performed this week by the *New York Times* in its publication of Mr. Swinburne's new tragedy "Locrine." This tragedy, comprising about 18,000 words, was forwarded by Mr. Harold Frederic (the *Times* correspondent in London) over the Commercial and Western Union cables, and was published promptly next morning. About five hours were occupied in transmission, and the work was remarkably well done. Some of the journals are inclined to belittle this piece of enterprise, and to question its utility, especially those which had secured advanced sheets from the American publisher, and had put the matter in type awaiting the intimation to "go ahead." The *Times* has distinguished itself in this respect once or twice before, and in 1884 obtained by cable the whole of the Spanish United States Commercial Treaty. The latest feat eclipses everything, and is seconded by a piece of work done by the Associated Press in handling one of Mr. Gladstone's big speeches.

The whole of the past week may, in fact, be said to have been one in which cable interest predominated. At the joint meeting of the American Institute of Electrical Engineers and the New York Electrical Society, on the 15th inst., Mr. Charles Cuttriss presented an able and instructive paper on "Improvements in Apparatus for Ocean Telegraphs." This was supplemented by an interesting communication from Mr. T. D. Lockwood, and was followed by a brief but animated discussion in which ocean telephony, for the present at least, received a *quietus*. Among those present was Capt. Trott, of the Anglo-American cable repairing steamer, "Minia," which has been in port here at the Erie Basin dry dock, undergoing repairs rendered necessary by damage sustained in heavy weather in the North Atlantic. The "Minia," as is probably well known in England, was not specially constructed for cable work, but under the command of Capt. Trott she has rendered first-class service. The steamer has been visited by a number of electricians, being very much a novelty in these waters. All have been hospitably received, and many have realised for the first time the magnitude of the difficulties involved in maintaining intact the slender lines of cable that stretch between the Old and the New World.

Work is about to cease for the winter on the new subways. For months past a number of our main thoroughfares have looked like those of Paris in times of *emeutes* and barricades, and many of the citizens who were loud in their complaints against the aerial wires have been warmest in their denunciations of the present condition of things. The work that has been done has yet to undergo the practical test of operation and of time, and it will be years before any real solution of the problem will be arrived at. It is somewhat significant that latterly our Board of Electrical Control has been seriously discussing the best type of electric light pole, and that under one of its permits an order has actually been placed for 250 miles of aerial electric light wires, Nos. 4 and 6. This magnificent order, I may perhaps mention, was secured by the Callender Company. In other cities the old fight between the electric companies and the city authorities as to burying the wires goes on without much net result.

Although the decision of the United States Supreme Court in the Bell patent case has now been expected for some time, it has not yet been handed down, and uncertainty reigns supreme. The stock of the American Bell Telephone Company remains firm at high quotations, in spite of mysterious reports and whispers as to the intentions of the Court. The decision may come next week, and it may not come until January. Should it be in any degree unfavourable, there will be a tremendous outburst of telephonic speculation, for which even now preparations are being made; but the present Bell system is strong enough probably to withstand assault from every quarter.

Mr. Gould's mission to England is variously regarded and as variously commented on. It is understood that he seeks once more to have Western Union listed on the London Stock Exchange, and it is said that the house of Baring is his agent in the matter. Mr. Gould's wishes and aims are known, however, to no one but himself. From the course taken by affairs in the New York Stock Market since he sailed away, it is to be inferred that he finds it as easy to direct operations here as though he sat in his office on Broadway instead of being within sight of the Peabody statue.

CORRESPONDENCE.

THE DISEASES OF DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the discussion on the above I am reported in your issue of the 2nd inst. to have thought "that unequal sparking of brushes was due to the field being made unequal by the presence of masses of iron about one of the poles." What I really *said* was as follows:—"There is a tendency to unequal sparking in some machines where a Gramme armature rotates between the poles of a single horseshoe magnet, owing to the lines of force dividing unequally in the two halves of the armature. More lines go through the half nearer the yoke than the farther half, and the brushes in consequence may have to be adjusted not quite opposite each other. In machines where the magnet is reduced to half its thickness by boring out to form the polar recess this tendency becomes noticeable, but as the thickness at the poles is made greater the tendency disappears. With the drum type of armature it does not exist, as each convolution of conductor embraces *all* the lines of force, and not half only, as in the ring type." It might be possible to obtain a more equal distribution of field in the two halves of the armature by placing the latter excentrically in the field, its centre being rather further from the yoke than the centre of the polar cavity.—Yours, &c.,

W. B. ESSON.

London, Dec. 5th, 1887.

SPRINGS ON TELEGRAPH WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: No writer in your columns has yet called attention to the following fact, which is the most vital in determining the range of relief which the springs are able to render the line wire under excess loads.

That fact is that *the relief increases much faster than the stress.*

If we set the 100lb. copper wire, of 100 yards span, up to a tension of 82·5lb. at 22deg. F. with springs, as we should set it to the same 82·5lb. stress without springs, we practically disallow relief, making it *nil* at that starting point.

Then let the falling snow and rising wind increase the stress to 165lb.

Then the springs will give the line wire relief equal to a horizontal wind force of no less than *5·6 foot-tons* on every pole 20ft. high to centre of pressure, carrying 20 wires, each wire laden with 24lb. of snow per span, and *the springs give this enormous relief without themselves or the wire being in the slightest degree overstrained.*

Unaided by springs, the line wire, when loaded with 24lb. of snow per 100 yards span, could not sustain any wind pressure at all without being overstrained.

It is because the spans as now hung are mostly only about 66 yards that the lines stand as they do.

If these 66-yard spans were all furnished with springs the problem would no longer be how to preserve the *wire*, but how to sustain the *posts* against storms; for certainly the posts would give way first unless powerfully stayed.

I append a diagram and table, which will speak for themselves.—Yours, &c.,

FRANK CAWS.

Sunderland, Nov. 26th, 1887.

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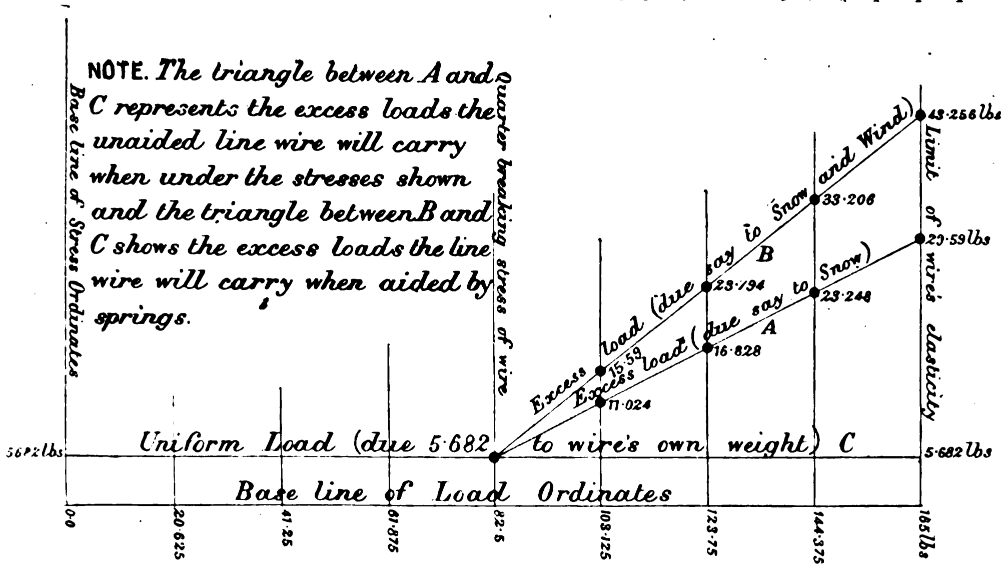
DIAGRAM showing relief afforded to a 100-yard span of 100lbs. copper wire, by springs stretching ·4674ft. per span per 82·5lbs. stress.



NOTE.—Occasionally the weight of snow on a wire equals, or even exceeds, 24lbs. This diagram shows that the line wire has no reserve elasticity for such wind pressure as may be encountered when the 24lbs. of snow tube is present. But the springs give the required reserve to enable the wire to resist such wind pressure.

TABLES SHOWING THE EFFECT OF A GATHERING LOAD OF SNOW AND WIND ON THE STRESS OF A 100-YARD SPAN OF COPPER WIRE WEIGHING 100LB. PER MILE.

NOTE.—The modulus of elasticity (14,500,000lb. per inch) which I have used in these tables is low, for doubtless it is in very hard wire often as high as 16,900,000lb. per inch, or thereabouts. But in view of many practical contingencies I think the modulus I have used will give results very nearly true. The effect of a higher modulus would be to reduce the dip and load for a given stress, and to increase the dip and reduce the stress for a given length of expansion. Books of reference differ as to the modulus for copper wire, and doubtless the wire itself differs also; but judicious experimenting would soon discover a good average modulus.

TABLE A.—Line Wire without Springs.

Stress.	Stretch of Wire.	Length of Catenary.	Span.	Dip.	Load.
lbs.	ft.	ft.	ft.	ft.	lbs.
0·000	·0000	299·71346	300·0	0·0000	5·682
82·500	·3459	300·05936	300·0	2·5842	5·682
103·125	·4324	300·14586	300·0	4·0508	11·024
123·750	·5188	300·23226	300·0	5·1114	16·828
144·375	·6053	300·31876	300·0	5·9884	23·248
165·000	·6198	300·40526	300·0	6·7522	29·590

TABLE B.—Line Wire with Springs.

Stress.	Stretch of Wire.	Stretch of Spring.	Length of Catenary.	Span.	Dip.	Load.
lbs.	ft.	ft.	ft.	ft.	ft.	lbs.
0·000	·0000	·0000	299·71346	300·4674	0·0000	5·682
82·500	·3459	·4674	300·05936	300·0000	2·5842	5·682
103·125	·4324	·5843	300·14586	299·8331	5·4349	15·590
123·750	·5188	·7012	300·23226	299·7662	7·2381	23·794
144·375	·6053	·8180	300·31876	299·6494	8·6726	33·206
165·000	·6918	·9349	300·40526	299·5325	9·9012	43·256

NOTE.—In these tables, as well as in the table published in *The Electrician*, November 4th, page 540, the slight difference between the catenary and parabola is neglected, as being of no practical moment where the dips are so small in proportion to the spans.—F. C.

STATIC *VERSUS* DYNAMIC BALANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of last week Prof. S. P. Thompson is reported to have said "Every engineer worthy of the name knows that . . . a four-pound weight at 3in. from the axis of rotation, though balanced statically by a one-pound weight at 12in. from the axis, is not balanced dynamically, for the moments of inertia about this axis are not equal. On the contrary, a four-pound weight at 5in. is balanced dynamically by a one-pound weight at 10in." I am afraid I am not worthy of the name of an engineer, or I do not know what dynamical balancing means. I have been in the habit of thinking that, provided the axis of rotation were a principal axis through the centre of gravity, a rotating body would be balanced dynamically in the sense of there being no stress on the axis, whatever the speed of rotation, and that the balancing of the system did not involve the moments of inertia of the parts. If this is so, a four pound weight at 5in. from the axis, and a one pound weight at 10in. on the opposite side, if set spinning would produce the same stress on the axis as a two pound weight at 5in. unbalanced by any weight on the opposite side, while the four pound weight at 3in. and the one pound weight at 12in. would balance each other. The four pound weight at 5in. and the one pound weight at 10in. possess the same kinetic energy if small enough; but can Prof. Thompson use the word "balance" in this sense?—Yours, &c.,

Mk^2.

THE TRAINING OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your article on the above subject, and in the correspondence last week, I see that the idea prevails that the student, after having completed a course of electrical engineering at a technical college, is launched straight into the profession of electrical engineering—he is supposed to know the practical work as well as the theoretical. Now, the plan of my college, and of one or two others I know of, is to begin the education of the student by courses in mathematics, engineering, physics, mechanics, drawing, and electrical laboratory, the course being precisely the same as the mechanical engineering students go through; then, after he has completed his course he is assisted to get into some work as an articled pupil, where he will learn the practical part of the subject; but the prospect of his obtaining a paid appointment direct from the college is hardly entertained at all. I should think it would be impossible for any college to teach the practical part of electrical engineering as it is taught in works.

The opinion of your correspondent, Mr. Walker, concerning theoretical knowledge is not universally held by all firms, one of which I know offering to waive premium for theoretical knowledge. Apologising for taking up your valuable space,—Yours, &c.,

AN ELECTRICAL ENGINEERING STUDENT.

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TABLE giving Relative Costs of Fuel and Labour for Dynamo and Battery.

Conditions of Working.		Hours per annum per electrical horse-power.	Working cost of engine in decimals of a penny per elec. horse-power per hour.			Working cost of battery in decimals of a penny per elec. horse-power per hour.		
Engine Data.	Electrical output in horse-power.		Labour at 30s. per week.	Coal.	Total.	Labour at 4s. per week.	Fuel.	Total.
Steam Engine, taking 4lb. of coal per indicated horse-power per hour; coal at 20s. per ton. Efficiency of dynamo and transmitting mechanism, ·68	10	1,800 (about 5 hrs. per diem)	1·04	·63	*1·67*	·13	20·40	*20·53*
		1,100 (about 3 hrs. per diem)	1·70	·63	*2·33*	·22	20·40	*20·62*
Ditto, ditto. Coal at 15s. per ton	10	1,800	1·04	·47	*1·51*	·13	20·40	*20·53*
		1,100	1·70	·47	*2·17*	·22	20·40	*20·62*
Small Steam Engine, taking 8lb. of coal per indicated horse-power per hour; coal at 20s. per ton. Efficiency of dynamo and transmitting mechanism, ·56	1	1,800	10·40	1·53	*11·93*	1·38	20·40	*21·78*
		1,100	17·01	1·53	*18·54*	2·26	20·40	*22·66*
Ditto, ditto. Coal at 15s. per ton	1	1,800	10·40	1·15	*11·55*	1·38	20·40	*21·78*
		1,100	17·01	1·15	*18·16*	2·26	20·40	*22·66*
Gas Engine, taking 20 cubic feet of gas per indicated horse-power per hour; gas at 3s. per 1,000 cubic feet. Efficiency of dynamo, and transmitting mechanism, ·68	10			Gas				
		1,800	1·04	1·05	*2·09*	·13	20·40	*20·53*
		1,100	1·70	1·05	*2·75*	·22	20·40	*20·62*
Ditto, ditto. Gas at 2s. 6d. per 1,000 cubic feet	10	1,800	1·04	·88	*1·92*	·13	20·40	*20·53*
		1,100	1·70	·88	*2·58*	·22	20·40	*20·62*
Small Gas Engine, taking 30 cubic feet of gas per indicated horse-power per hour; gas at 3s. per 1,000 cubic feet. Efficiency of engine and dynamo, ·56	1	1,800	10·40	1·28	*11·68*	1·38	20·40	*21·78*
		1,100	17·01	1·28	*18·29*	2·26	20·40	*22·66*
Ditto, ditto. Gas at 2s. 6d. per 1,000 cubic feet	1	1,800	10·40	1·07	*11·47*	1·38	20·40	*21·78*
		1,100	17·01	1·07	*18·08*	2·26	20·40	*22·66*

PHŒNIX FIRE OFFICE RULES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: May I ask you on behalf of the Phœnix Fire Office, and in order to set ourselves right in the eyes of the public as well as of our competitors, to allow me to explain that the "Phœnix Rules for Electric Lighting Installations" (to which your journal has recently borne favourable testimony) do not lay claim to any formal sanction by the Fire Offices Committee. If any merit belongs to these "Rules" it is due to their practical value as tending to promote safety from fire, and thus to protect an approved mode of lighting from any unfair suspicion of danger.—Yours, &c.,

F. B. Macdonald, Secretary.

Phœnix Fire Office, 19, Lombard-street, London, E.C., 6th Dec., 1887.

PRIMARY BATTERIES FOR HOUSE LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I quite think with Mr. Ross that the primary battery has a useful sphere of action, even as a lighting agent; but unless Mr. Ross can show at the proposed trial that expenditure in oxydising liquid need not be more than that for zinc, I fear it will be extremely limited.

On referring to Mr. Nursey's paper I find the cost of fuel in the Holmes and Burke battery to be 8s. 6d. for five electrical horse-power-hours, or 1s. 8½d. per electrical horse-power-hour, and that the labour and attention required for a battery of this output would range from a quarter to half an hour per day, with one hour per week for recharging. On this basis I have constructed the above table, which serves to show the approaching limit at which such a battery could successfully compete with an engine and dynamo.

The sum fixed for labour on battery is the minimum that I conceive an experienced man would ask for the attention required.

In considering the question of engine labour, it must be remembered that a man at 30s. per week, with only a one horse-power installation on his mind, would in most cases be employed on other useful work; nor is it impracticable for the householder to work his own engine, and only benefit by such labour as would be required for a battery. In such a case the difference in working cost would be very considerable, and would approach to $\frac{1}{10}$th that of a battery. It is to be hoped that, if the trial in question comes off, the details of working cost will be specified per electrical horse-power-hour and not per lamp-hour, which may mean anything, according to the point of efficiency at which the latter is worked.—Yours, &c.,

N. G. Thompson.

4, Queen Victoria-street, London, E.C., Dec. 6, 1887.

TENSILE STRENGTH OF ELECTROLYTIC COPPER.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: While the late action of Elmore *v.* Pirrie was being tried before Mr. Justice Kay, Messrs. Goodwin and How, civil engineers, of Westminster, who were engaged in the case, called my attention to a statement in my work "Electro-Deposition" relating to the tensile strength of copper, which is erroneous and misleading, and I shall esteem it a great favour if you will kindly allow me to correct that statement in the columns of your widely circulating paper. On page 144 of my book a comparison is drawn between the tensile strength of sheet copper as manufactured by the ordinary process and copper deposited by the Hallett-Elmore dynamo, which would lead readers to believe that the latter material broke under a tensile strain equal to 32 tons per square inch of original area, which is not the fact, and I find that Mr. Elmore, who gave me those figures in his own handwriting, had taken from Mr. Kirkaldy's certificate the stress per square inch of the *fractured* area, and coupled that with the elongation. The certificate referred to, which was produced in court during the trial, shows that the copper stood 15·2 tons per square inch of original area, and elongated 38·2 per cent. To ascertain the comparative strength of electrolytic copper deposited very slowly and ordinary copper, Messrs. Goodwin and How carried out a series of trials, the results of which showed that the latter was the stronger of the two. Trusting you will favour me by inserting this explanation.—Yours, &c.,

Alexander Watt.

THE CONDUCTIVITY OF GLASS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Cherrill, in his "Notes on the Conductivity of Glass," *Electrician*, December 2nd, 1887, has omitted to mention that the phenomenon of the semi-decomposition of the lead glass in our lamps by an electric current aided by heat, was pointed out by me, and proved by Mr. C. H. Stearn, managing director of our company, to be electrolytic action.

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The following, which may be of interest, is quoted verbatim from a letter dated February 26th, 1885, which Mr. Stearn kindly sent me referring to the subject. I was then submanager under Mr. Cherrill.—Yours, &c.,

C. FARADAY PROCTOR.

70, Rue des Sarrazins, Lille, 3rd December, 1887.

"My dear Mr. Proctor, February 26th, 1887.

"I have to thank you for pointing out the continuance of the black deposit to which I formerly directed your attention, and for the close observation which has traced it, at least in part, to a cause that was not then suspected, viz., electrolytic action. I have embedded flat plates of platinum in a block of the glass, and produced the blackening in less than one minute, the glass being very hot. I reversed the current, and then got the second pole black. But the most important point I want you to observe is, do small gas bubbles appear on the other pole in the glass? for in every experiment I managed to blow large bubbles in the glass with the gas evolved. If this takes place, it of course sets up leakage and accounts for bad vacua.—Yours very truly,

"(Signed) C. H. STEARN."

MR. WEBSTER'S CHALLENGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the letters of Messrs. Ross and Shippey, my only conditions are that the cells of competing batteries shall be of similar size—say, of one gallon capacity (surely, this does not exclude any *shape?*), and they must not be colourable imitations of mine.

I leave all other matters to the arbitrator; he, of course, must judge for himself. My offer remains as before; the competition being purely for scientific reasons, and not for commercial purposes. It having been stated that primary batteries will not answer for lighting, I want to prove the fallacy of such a statement; but having a particular battery of my own construction I cannot judge impartially of the merits of others.—Yours, &c., WILLIAM WEBSTER, JUN.

P.S.—My battery has very little in common with the "Holmes-Burke."

TRADE DISCOUNTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am quite prepared to join issue with Mr. Fricker on the question of the advisability of the use of advanced mathematics in ordinary business transactions, such as the one referred to, or upon any other question upon which we may happen to hold different opinions, but I must stipulate that he fights fair, or I shall leave him the field to himself.

I maintain that it is not only practicable but greatly to the advantage of discussions on subjects such as are admitted to your columns that personalities of all kinds should be avoided. The time occupied in considering how to give your adversary *one* that will make him feel, and the time occupied in recovering from the *one* that he usually returns would be very much more profitably employed in considering how you are to meet his argument.

Now, as to the matter in hand. My rule was taken from actual practice of years past, and was not deducted from Mr. Money-Kent's formula, though, of course, it follows that unless either my rule or Mr. Kent's formula be wrong they must work out to the same figures.

Next, I maintain that for one boy or clerk who could work from Mr. Kent and Mr. Fricker's formula, however simple it may seem to them, at least a hundred would be found who could work quite easily from my rule, and a great many could figure out the principal discounts in their heads.

Mr. Fricker and Mr. Kent appear both to have been unfortunate in their business experience in this matter; but I hardly see that, because they have had certain peculiar experiences, it should be assumed that all business transactions are conducted in the same slipshod manner; and still less am I able to understand how the matter is to be improved by the use of a formula that would be absolutely unintelligible to nine-tenths of those who are supposed to use it. It is clerks and office boys who work out these figures, not heads of firms or managers; their time is usually too valuable. And there are daily, in the city of London, to go no farther, numbers of minute calculations worked out with reference to discounts and profits in houses where perhaps not a single member of the staff knows anything of advanced mathematics. Accountants do not use advanced mathematics.

Further, I took the opportunity presented by the appearance of Mr. Money-Kent's article to enter a protest against the growing tendency to drag mathematics into everything. I have as high an admiration of mathematics as any one, but I like them as servants, not as masters; and I like to take the shortest, simplest, and surest road to my object, which, to my mind, mathematics do not always furnish, certainly not in the present instance. Mathematics and theory are dangerous tools; you can never be certain that you are using them aright until you have clearly proved them by practice.—Yours, &c.,

SYDNEY F. WALKER.

[We think that this matter should now be allowed to drop. —ED. *E.*]

WORKING MEN'S CONFERENCE ON TECHNICAL EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A conference on technical education has been arranged to take place at the Royal Victoria Hall, Waterloo Bridge-road, on Wednesday, 14th inst. Its object is that the employers and workmen, especially of this neighbourhood, may meet in a friendly way, together with others who take a special interest in the subject, and discuss it from their several points of view, particularly with regard to possible legislation. It is a matter equally important to masters and workmen, and their interests with respect to it are identical if they would but recognise the fact. We have requested that all parties will sink politics in considering it, and think only of the general welfare.

Sir Henry Doulton has kindly promised to take the chair, and two short papers will be read (one by Dr. Fleming, of University College; the other by Mr. Bockett, a working man), to be followed by a discussion. May I make known through your columns that I shall be happy to send a ticket for the platform or a reserved seat to anyone applying for the same?—Yours, &c., EMMA CONS, Hon. Sec. and Trustee.

Royal Victoria Hall, Waterloo Bridge-road, S.E.,
Dec. 7, 1887.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

16,376. C. B. NOBLE and R. D. NOBLE. London. Improvements in electric arc lamps (complete specification) November 29.

16,398. B. W. WARWICK. London. Automatic machines for the supply of liquids on draught by electrical and other means. November 29.

16,455. H. THAME. London. Improvements in secondary or storage batteries. November 30.

16,458. A. A. C. SWINTON. London. Improvements in electric telephones. November 30.

16,473. S. S. BROMHEAD. London. An electrical signalling device for railway purposes (S. T. Street, United States) (complete specification). November 30.

16,474. B. W. WARWICK. London. Improvements in automatic machines for the supply of electricity for medical and other purposes. November 30.

16,489. A. MELVILLE. London. The production of force (power) for mechanical purposes, superseding the use of steam or gas engines, more especially for the generation of electricity. November 30.

16,537. F. WYNNE. London. Improvements in or pertaining to means or apparatus employed in the application of electricity to propel vehicles; applicable also for other purposes. December 1.

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16,554. G. BINTER. London. A new or improved electric apparatus for indicating distant water level, and similar purposes (complete specification). December 1.

16,558. A. WRIGHT. London. Improvements in apparatus for measuring and regulating electric currents (complete specification). December 2, 1887.

16,559. A. WRIGHT. London. New or improved means of and apparatus for measuring currents. December 2, 1887.

16,565. E. THOMAS. Battersea. Electrical measuring instruments. December 2, 1887.

16,583. F. C. PHILLIPS and H. E. HARRISON. London. A method of regulating electric arc lamps. December 2.

16,584. F. C. PHILLIPS and H. E. HARRISON. London. A method of controlling or regulating electric motors. December 2.

16,603. A. J. BOULT. Middlesex. Improvements in or relating to electric lamps for velocipedes or the like (R. Weber, Germany). December 2.

16,623. W. T. GOOLDEN and L. B. ATKINSON. Clapham. Improvements in dynamo electric generators and motors. December 2.

16,643. F. C. LYNDE. Manchester. Improvements in apparatus for indicating static or dynamic force or other measurements on prepayment of a coin. December 3.

16,669. M. BAILEY and J. WARNER. London. An improved secondary battery, combined with a miner's lamp (complete specification). December 3.

16,678. E. W. BECKINGSALE. London. Improvements in laying underground electric conductors. December 3.

16,717. P. A. NEWTON. London. Improved electro therapeutic apparatus (F. J. Kenenper, United States). December 5.

16,728. A. HEINTZ. London. Improvements in the manufacture of incandescent electric lamps (complete specification). December 5.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

December 3, 1887.

15,719. J. ROOTS. Kent. Improvements in apparatus for administering electric currents. December 1, 1886.

16,608. DESMOND G. FITZGERALD. London. An improved method for the production of coherent masses of peroxide of lead, for use as voltaic battery elements, and for use in electrolytical and metallurgical operations. December 17, 1886.

1,390. R. C. JACKSON. London. Improvements in dynamo-electric machines and electro-magnets. January 28, 1887.

1,609. W. J. BARNSDALE. London. Improvements in and connected with electrically wound clocks. February 1, 1887.

14,893. L. G. WOOLLEY. London. Improvements in generation of electricity. November 1.

14,908. C. R. GOODWIN. Paris. Improvements in electric batteries. November 2, 1887.

December 7, 1887.

15,774. I. PROBERT. London. Improvements in electrical switches and appliances connected therewith. December 2, 1886.

1,741. S. LUDWORTH and C. K. FALKENSTEIN. London. Improvements in apparatus for making and breaking electrical currents. February 3, 1887.

1,862. C. D. ABEL. London. For secondary batteries. (A. Dun and F. Hasslacher, Germany.) February 5, 1887.

1,929. C. D. ABEL. London. Improvements in galvanic batteries. (A. Dun and F. Hasslacher, Germany.) February 7.

PATENTS SEALED.

November 29, 1887.

13,987. J. G. STATTER and S. L. BRUNTON (Middlesex), J. W. KEMPSTER (Essex). An improved collector or brush for dynamo or magneto-electric machines or motors. October 30, 1886.

16,823. E. BARBIER and LECLANCHÉ. Paris. Improvements in electrical batteries, and in the manufacture of depolarising bodies to be used therein. December 22, 1886.

7,934. A. B. GILL. London. An improved electric switch. June 1, 1887.

December 2, 1887.

13,111. W. WARD. York. Improvements in electric lamps. October 14, 1886.

14,033. C. D. ABEL. London. An improvement in electrolysis (Siemens and Halske, Germany). November 1, 1886.

15,165. M. WILLIAM. Fulham. Improvements in the manufacture of incandescent electric lamps. November 22.

17,056. G. KAPP. Surrey. Improvements in dynamo-electric machines. December 29 1886.

3,749. K. MAXYMILIAN. Glamorganshire. Improvements in electrical apparatus for the prevention of corrosion and formation of scale in steam boilers. March 11, 1887.

7,079. E. WILSON. Germany. Improvements in dynamo-electrical machines. May 14, 1887.

11,356. C. RUNELS. United States. Improvements in electric couplings. August 19, 1887.

SPECIFICATIONS PUBLISHED DURING THE MONTH.

114, 1887.—W. A. LEIPNER. Dynamo-Electric, &c., machines. (Price 8d.)

13,092, 1887.—W. R. LAKE. (La Société A. Crute & Cie.) Carbon filaments for incandescent electric lamps. (Price 4d.)

13,454, 1887.—R. T. Turnbull. Incandescent electric lamps. (Price 6d.)

LEGAL INTELLIGENCE.

S. Z. Ferranti v. Gaulard and Gibbs.

This petition was mentioned before Mr. Justice Kekewich, in the Chancery Court of the High Court of Justice, on Monday. Mr. MARTEN, Q.C., said the matter arose on a petition which came before his lordship some time ago. The petition was by the plaintiff that he might be allowed to amend his petition by "correction, alteration, or disclaimer." It had been agreed between the parties that the words "correction and alteration" had been improperly used, and it was agreed, therefore, to amend the petition only by disclaiming certain facts. An order to that effect was made, and it was understood at the time that the terms were agreed to. The question arose on the drawing up of the order as to the amount of time to be given to them to disclaim.

Mr. ASTON, Q.C., interposing, said he did not know why this matter had been brought up again. As far as he knew the whole thing was settled, and he protested against the time of the Court being taken up in this way.

Mr. Justice KEKEWICH having sent for the Registrar who had the carriage of the order, Mr. Koe, and consulted with him, said: The dispute appears to me to be a most trivial one. He then made a slight verbal alteration in the order himself, which he initialled, and observed: It can now go. I shall not allow any costs on either side.

Sharp and Kent v. M. D'Humy.

MONDAY, DEC. 5th.—Before Mr. VEREY, Official Referee.

Mr. Noble (counsel) appeared for the plaintiffs, and Messrs. W. H. Smith and Son, solicitors, for the defendant.

This was the reference of an action upon a bill for carbons supplied to the amount of upwards of £100, the defendant bringing a counter-claim for £1,000 damages for loss occasioned to the defendant through the alleged badness of the carbon plates.

The case was opened before the Official Referee at a previous hearing on November 18th.

Mr. SMITH now said he had to ask for an adjournment by reason of the illness of the defendant D'Humy, and he produced two doctors' certificates in support of his proposal.

The OFFICIAL REFEREE, however, remarked that he saw no evidence on which to adjourn, and said: The defendant is not here, and unless you propose to call evidence to-morrow it is no use my adjourning. Are you prepared to pay money into court?

Mr. SMITH: Certainly; but our counter-claim being for £1,000, the other side must also pay in some amount.

Mr. NOBLE: Very well. We will pay into court £500 before 4 o'clock to-day, if the defendant will pay in £150 by same hour.

Mr. SMITH: I cannot agree to that in defendant's absence.

After some further conversation,

The OFFICIAL REFEREE said: Defendant being away you have closed your case. There is no evidence on the counter-claim, and I shall go on with the case. I am not satisfied with the reasons for an adjournment. You are quite at liberty to go to the Court at the earliest possible time if you like, and I will withhold my award if you ask.

Mr. SMITH: Very well, I will do that.

Judgment was given for the plaintiffs.

COMPANIES' MEETINGS.

The Old Atlantic Cables and the Newfoundland Land Company.

The ordinary general meeting of the Newfoundland Land Company (Limited) was held on December 5 at Winchester House, Old Broad-street, E.C., followed by an extraordinary general meeting.

Mr. HENRY WEAVER, managing director of the Anglo-American Telegraph Company, occupied the chair.

The SECRETARY (Mr. T. H. Wells) having read the notice convening the meeting and the minutes of the last meeting,

The CHAIRMAN briefly proposed the adoption of the report and accounts to the 31st December, 1886, intimating that the important business before

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the meeting on that occasion had to be dealt with at the extraordinary meeting which had been called.

Sir JAMES ANDERSON seconded the motion, which was adopted.

The CHAIRMAN afterwards proposed the re-election as Director of Mr. Cyrus Field.

Mr. GEORGE HEIRON and Mr. WM. ABBOTT suggested that this motion should be deferred until the close of the extraordinary meeting, which was agreed to.

The extraordinary meeting was then held.

The CHAIRMAN: The important business of this meeting really is to ascertain how far the affairs of the Company are for the future to be carried on. As you are aware, the present Board agreed that they would remain in office until they had obtained the grants of land applied for. We have now obtained all the grants we are likely to obtain, because the grants which had been applied for in addition to those received have already been allotted, and therefore we cannot have them. We have now obtained a total of 39,002 acres, and there are a further 21,998 acres which may be applied for by the Company. I went on a former occasion into the history of this concern, and I think that I had better repeat what I told you at that time. The land upon which this Company was incorporated formerly belonged to the Newfoundland Telegraph Company. That company was incorporated by charter from the Newfoundland Government about the year 1856, and it was incorporated for the purpose of laying a line or lines of submarine cable between Newfoundland and this country, and to erect a system of telegraphs on the island of Newfoundland. The Government of the Colony while granting this charter did not give any subsidy to the Company, but gave them the selection of 100 square miles of land to work in any way they might think desirable. There was a clause in the charter of the Newfoundland Telegraph Company giving them the power of fusing their undertaking into the company which actually laid the Atlantic cables, and which you are aware was the Anglo-American Company, as the successors of the Atlantic Company. Now, at the time of this fusion in 1873 it was found at the last moment that the Anglo-American Company had no power whatever to hold land, and the consequence was that this Company was incorporated for the purpose of taking over the land belonging to the Newfoundland Telegraph Company, and to dispose of it or work it in any way that seemed most desirable. That was the history of the commencement of this Company, and the shareholders of the Newfoundland Telegraph Company received for every share which they held in that company a land share, so that really no money whatever was subscribed. They received a share of the Land Company, in addition to the stock of the Anglo-American Company which they got for their undertaking. There was a certain sum of money which belonged to the Newfoundland Telegraph Company, which was taken over by the Land Company, who became responsible for the debts of the Telegraph Company, the balance to be used in any way that appeared most desirable to the Board. The Directors of the Newfoundland Telegraph Company were asked and urged to accept seats at this Board, and as no one else was willing to accept them we were obliged to take the place, and the first thing we did was to consider what we were going to do with the land. What we really did do was this—we fitted out two expeditions. I think they went out in 1874 and 1875. They went to Newfoundland to see whether in reality there was anything to be done with the land, and when they came back their reports were so unfavourable that the Directors decided that they had better not ask for the money which was necessary to work the land which the Company had, and the Board returned the money which they had already raised by preference shares—something like £4,000. At that time, and at several meetings since, I have recommended the shareholders to wind up the Company, for I really did not see that anything was to be got out of it in any way; but at the wish and request of the shareholders we were desired to retain our seats, and, in fact, wait until something turned up. That was really the whole thing. On the last occasion we proposed that the Company should be wound up, but the shareholders asked us to wait until the land had been allotted. We consented to that, and now the land has been allotted—at least as much as we can get—and we now ask you what is the next thing to be done. We have told you on several occasions that we are not disposed to do anything else ourselves. We understand nothing about land or mining. We are simply telegraph men, and we do not wish to go outside our functions. We therefore asked you in the report either to appoint a committee to elect new Directors or to wind up the Company. I find now, looking at the proxies which the shareholders have sent in, that a very large majority are in favour of a committee being appointed for the purpose of electing a new Board—a majority, in fact, of 5,231 shares, or rather more than that, because we have had some come in this morning. The majority, I find, is 6,260 shares in favour of a committee being appointed to elect a new Board. We have not the slightest objection to that course being taken, and we shall only be too happy if a committee is appointed to elect new Directors.

Sir JAMES ANDERSON: I should like to add a few remarks by way of showing that we have left no stone unturned to find out whether anything could be done for this Company. Two gentlemen were recommended to us by the School of Mines—geologists—and they gave us a report, which is accessible to any shareholders who wish to see it. They found out nothing that would induce us to put our money into the concern, or that would justify us in recommending you to do so. Some personal friends of mine engaged in the metal trade in London, who spend a great deal of money in looking after deposits of copper which seem to offer favourable conditions of working, expended at least £25,000 in explorations on our property, and had they got anything worth working we should have very likely come to you with a new Board who understand the business, and have asked you to risk something on that venture; but they lost their money. We then had a fish scheme brought before us, and when I was in Newfoundland myself I learned a great deal about what that sort of thing was. I felt that I would not put a shilling of money into it, and after Mr. Bompas, Mr. Weaver and myself examined the matter carefully, we decided not to touch it. From that time we have seen nothing and known nothing about Newfoundland to encourage you to put your money there or to go there.

Mr. WM. ABBOTT said that the shareholders must feel very much indebted to the Directors for having remained on the Board so long. They had said very properly that they were telegraph men; and if men would only keep to what they understood a great deal of public money that was now lost would be saved. Reference had been made by Sir James Anderson to the visit of geologists to the Company's property, and to their finding nothing; but the fact remained that in Newfoundland there were some of the richest copper deposits known. There was now a rise in the price of copper, and the position of affairs was therefore totally changed to what was the case some little time ago. He was recently at Swansea, where he saw large smelting works, and there were immense heaps of copper ore there which he was informed had come from Newfoundland. It was quite a mistake to imagine that there was nothing in Newfoundland but codfish. He believed the place was rich in minerals, and therefore he did not wish to see the Company wound up. At the same time he thought that the Directors had taken a wise course in appealing to the shareholders as to what steps should be taken in regard to the future of the Company, and, as the Chairman had said, a majority had answered in favour of appointing a committee to select a new Board. They had now 39,000 acres allotted to them out of their 100 square miles, and he would be glad to hear what difficulties the Newfoundland Government placed in the way of allotting to the Company the balance. He did not think that the Government of the Colony had kept good faith with them, because whenever it was desired to have a free grant of land allotted to them it appeared that someone had stepped in before them. He thought that what the meeting had to do that day was to follow the advice of the Directors and appoint a committee with the view of picking out three or four gentlemen who would take the place of the present Directors. The Company was not entirely penniless, for he saw that they had £320, and there were also 6,774 shares unissued. It would be said that those shares were not worth much—and perhaps not; but he would suggest that when a new company was formed the shareholders should be offered those shares at 6s. each. That would produce over £2,000, which would keep the thing going a little longer. Their position, therefore, was not entirely hopeless. It might be said would the shareholders take those shares at 6s.? Well, if the Directors were in a position to offer them at 5s. he would at once agree to take the lot at that figure, and see whether they could not develop the 39,000 acres of land which had been allotted to them, and whether they could not bring some influence to bear on the Newfoundland Government to grant them the balance of the land to which they were entitled.

The CHAIRMAN asked whether Mr. Abbott knew of any gentlemen who were willing to form the committee and to accept the liberal offer he had made to purchase the shares.

Mr. ABBOTT replied that he did, but that he would be glad to be given a few days to consider the matter. He would suggest Mr. George Heiron; and Mr. Arthur Baker had asked him (the speaker) to put his name on the committee. He had also just been informed that Mr. Greenip would go on. He thought that the shareholders had every reason to be much obliged to the Directors for what they had done.

Mr. HEIRON acquiesced in Mr. Abbott's remarks, and said that he had some knowledge of Newfoundland from surveys which had been taken there, and the parties making those surveys had spoken in very different language of the prospects of mining compared with what had been stated by the gentlemen referred to by Sir James Anderson. It was to be remembered that until o e went into the earth, one could not tell what the prospect in connection with mining would be. If the shareholders wound up the Company they would not get a farthing back. The annoying fact was that the Company were only to get 39,000 acres instead of 64,000, which the Newfoundland Government had promised them.

The CHAIRMAN: Oh no; that is not so. You will get the balance, but you must apply for it. You have a perfect right to apply that the balance should be allotted to you.

Sir JAMES ANDERSON: The great point is to send out the right people to select the right land.

Mr. HEIRON took it for granted that every assistance would be given by the office.

Sir JAMES ANDERSON replied that every possible information would be given.

Mr. DAVIDSON inquired whether there was still unallotted by the Newfoundland Government a sufficient quantity of land so as to give to the Company what they were entitled to.

Sir JAMES ANDERSON: Oh, yes, many times over.

The CHAIRMAN said that he thought the best course for him would be to propose the first resolution mentioned in the report, which was as follows:—"That a committee be appointed for the purpose of selecting a new Board of Directors, who will undertake the future conduct of the business of the Company."

Sir JAMES ANDERSON seconded the motion, which was carried unanimously.

The CHAIRMAN then proposed the appointment of a committee consisting of Mr. Geo. Heiron, Mr. Arthur Baker, and Mr. W. M. Greenip.

Sir JAMES ANDERSON seconded the motion, which was unanimously agreed to.

Two or three SHAREHOLDERS urged Mr. Abbott to join the committee, but that gentleman said he would prefer not to accede to the request, because his time was occupied in other ways.

The CHAIRMAN said that he had consulted Mr. Bompas as to the re-election of Mr. Cyrus Field, but that question need not come before the

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meeting, because Mr. Field had agreed to do whatever the other Directors did, and they were going to retire. Sir James Anderson and himself would be glad to appoint any day to see the committee.

Sir JAMES ANDERSON observed that whatever committee was appointed the Company would go on languishing unless they arranged to find some money.

Mr. HEIRON said that that would be a matter which would be gone into by the committee in conference with the new Board.

Mr. ABBOTT proposed a hearty vote of thanks to the Directors for what they had done. It had been a very thankless office for them, for they had been fighting against circumstances. They had brought their influence to bear on the Newfoundland Government, with results of which the shareholders already knew.

Mr. HEIRON seconded the motion, which was carried unanimously.

The CHAIRMAN, in acknowledging the vote, said they were much obliged to the shareholders. After all the Directors had not done much, but they had done all they could to obtain the land and they had succeeded to the extent mentioned. There was one fact certain, that whatever their work had been, the Directors had done for the shareholders gratuitously for fourteen years.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The directors of this company on Wednesday declared an interim dividend of 3s. per share, being at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended 30th September, and payable on the 23rd inst. The books of the company will be closed from the 16th to the 22nd inst., both days inclusive.—The traffic receipts of this company for the week ended Dec. 2nd amounted to £4,817.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of November was 3,343, estimated to produce £3,000, against 3,077 messages, producing £2,580, in the corresponding month of last year. The traffic receipts for the month of August, estimated at £2,250, realised £2,280.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts for the month of November are £2,115, against £1,876 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY.—This company announced the payment on the 4th January next of interest at the rate of 3s. per share on the preference shares of the company, less income-tax, for the quarter ending 31st December, 1887; and on the same day an interim dividend will be paid of 2s. 6d. per share in respect of profit for the quarter ended 30th September, 1887, on the ordinary shares of the company, free of income-tax. The company's register of the transfers will be closed from the 6th to the 13th January, both days inclusive.—The traffic receipts of this company for the month of November amounted to £53,454, and to £50,817 in the corresponding period of 1886, being an increase of £2,637.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—This company notify that the coupon on their Five per Cent. Australian Government Subsidy Debentures, due on the 1st January next, will be paid after that date at Messrs. Barclay, Bevan and Company's Bank, 54, Lombard-street, E.C. Coupons must be left three clear days for examination.—The directors have declared an interim dividend for the quarter ended 30th September last of 2s. 6d. per share.—The traffic receipts of the company for the month of November amounted to £39,000, and to £36,739 in the corresponding period of 1886. Increase, £2,261.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for November amounted to £22,000; from 1st January to 30th November they amounted to £242,880; while for the corresponding months of 1886 and 1885 they were £239,000 and £264,440 respectively.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY. — The traffic receipts of this company for the week ended December 2nd were £3,870, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended 30th November were £4,225.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half-month ended 30th November are £2,627, as compared with £2,357 in the corresponding period of 1886.

SOUTH METROPOLITAN ELECTRIC SUPPLY COMPANY (LIMITED).—This company was registered on the 26th ult., with a capital of £250,000 in £10 shares, "to produce electric, magnetic, or other force, and to supply the same for light and heat."

THE MAXIM-WESTON ELECTRIC COMPANY (LIMITED).—The following circular has been issued to the shareholders of the above company:—"Dear Sirs: At the request of a number of influential shareholders, the directors are pleased to be in a position to inform you that their business during the past year has been in excess of any previous year, notwithstanding the universal depression existing in nearly every branch of trade, and the very heavy opposition they have had to contend against. The complete installations fitted up during the present year, including steam or other motor power and all requisites, amount, to the 1st of this month, to about 200 arc lamps of 2,000 candle-power each, and about 5,000 incandescent lamps of 20 candle-power each. We have also during the past year had an increase in our usual orders, and the result to date is therefore satisfactory. All installations fitted up to date have given satisfaction, and the company have succeeded in securing orders in the districts where these have been fitted up, at even higher prices than those quoted by other companies. During this year the company have been successful in opening up a new branch, having secured the lighting of several large ocean-going steamers, which have been lighted successfully; and the company are promised the lighting of twelve new steamers, as soon as these vessels are built. The directors are pleased to be able to add that they have secured a new dynamo and lamp, by means of which they will be able to apply arc installations upon a scale for which there is infinitely greater requirement than heretofore. I refer to what is known as the 'Watt' system, comprising a dynamo and arc lamp of 150 candle-power. These are produceable at a reduction of 50 per cent. under the Weston system. The dynamo will also be suitable for Admiralty requirements, and we are in hopes of securing a trial order for several of these dynamos. We will be able to supply dynamos capable of running from 60 up to 1,000 lamps each machine, at varying speeds of from 200 up to 1,000 revolutions per minute. The price at which we will be in a position shortly to supply these machines will be less than that of any other dynamo maker in the market. The company are already in receipt of inquiries for the dynamo from all parts of the world, and have had the opinion of several of the leading experts in the country, all of whom are agreed as to the mechanical and electrical efficiency and suitability of the machine. The directors may congratulate the proprietors on the extent and suitability of their new factory, having already found it necessary largely to increase their fixed plant, and this fact, with the amount expended during the past year for experiments in connection with the dynamo named, has decided the directors to offer to the shareholders the balance of the 50,000 shares left in their hands to issue 'as and when required' at 5s. each, par value. The directors are happy to report the steady growth of business, the prospects of the company being now better than at any past period. The principal difficulties they have hitherto had to contend with have been their inability to supply the arc system in a distributed form, and there is no doubt that the small arc lamp now perfected will enable the electric light to be applied to the cities and towns in Britain and Europe generally on a large scale (as is now the case in America) upon economical terms. The directors hope they will be supported by the shareholders in the matter of capital in applying for these shares, after having, during several years of arduous labour, succeeded in bringing the company to a first position among the electric lighting companies in Europe, with only about 10 per cent. of the capital at the disposal of competing companies. In the event of the shares being over-applied for, the shares will be allotted *pro rata* to the shareholders.—Yours, &c.—HUGH WATT, M.P., Chairman."

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. DEC. 7.		BUSINESS DONE WEEK ENDING DEC. 7. Highest.	Lowest.
Anglo-American	37,	38	37¾	37
Do. Preferred	62,	63	63¾	63½
Do. Deferred	13,	14	14¼	13 11-16
Brazilian Submarine	11¾,	12	12	11⅝
Cuba	11¾,	12¼	—	—
Do. Preference	18,	19	—	—
Direct Spanish	3½,	4	3 9-16	—
Do. Preference	8,	9	—	—
Direct United States Cable	8¾,	9	—	—
Eastern Telegraph	11⅛,	11⅜	11⅜	11⅛
Do. 6 per Cent. Preference	14¼,	14¾	14⅝	—
Do. 5 per Cent. Debentures, 1899	106,	109	—	—
Eastern Extension	12,	12¼	12¼	12 1-16
German Union	9¼,	9¾	—	—
Globe Telegraph and Trust	5⅜,	5⅝	5⅝	5½
Do. Preference	13⅛,	13⅜	13 3-16	13⅛
Great Northern	13½,	14	13¾	—
Indo-European	37,	39	37½	—
Reuter's	8,	8½	—	—
Submarine	130,	140	—	—
West India and Panama	1,	1¼	1⅜	1⅛
* Do. 1st Preference	9¾,	10¼	10⅛	9¾
Western Brazilian	8⅜,	8⅞	8 13-16	8
Western Union 7 per Cent. 1st Mortgage	117,	123	—	—
Do. 6 per Cent. Sterling Bonds	101,	104	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	9-16,	11 16	—	—
Oriental	¼,	⅜	—	—
†United Telephone	11¾,	12¼	12¼	12
United River Plate	4¾,	5¼	4⅝	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	1¾,	2¼	1⅞	—
Do. (fully paid)	2½,	3⅛	2¾	—
Swan	1¼,	1½	1⅜	—
Maxim Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	38,	39	38½	38
India Rubber, Gutta Percha and Telegraph Works	21,	22	21½	21

* xd. 9s. on account of arrears of dividend. † xd.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 500.—Vol. XX. FRIDAY, DECEMBER 16, 1887. Price 4d.

NOTES.

It would be difficult to say when the idea of rotating the field of a dynamo in one direction and the armature in the other first dawned upon the mind of the dynamo constructor. Probably Wheatstone and Gramme, and Varley and Wild, and Ladd and Siemens each contemplated the idea—and came to the conclusion that the game was not worth the candle. In another column will be found a description of a machine of this type designed by Lieut. Patten, of the United States Army. It will probably be conceded that the details of the design present points of merit, but it must still be doubtful whether the device ensures any real economical advantage.

The Corporation of Bradford are to be congratulated on the sensible and moderate tone which is so far characterising their dealing with the electric light question. Their determination to start a small central station for the public supply of electricity is the more noteworthy as they already own the local gasworks. It is a little unfortunate perhaps that the Gas Committee was unable to come to terms with Messrs. Schmidt, Douglas and Co., who for some time past have been supplying a certain number of lamps from their station at Kirkgate; but the arguments raised on either side are of a purely local character, and afford no data for the opinion of those not immediately on the spot. We trust, however, that the local company will be enabled to proceed with their own undertaking side by side with the forthcoming scheme of the Corporation.

Mr. Alderman Priestman's electrical science appears only to need amendment in one particular. His preference for a low tension over a high tension distribution, on the ground that the former affords absolute immunity from fire, while the latter does not, is scarcely in accord with generally accepted views.

Notwithstanding the labours of Clerk-Maxwell and Sir William Thomson it must be supposed that some time will yet elapse before electricians are able familiarly to discuss magnetic and electric induction through space in terms of the affectation of the ether. When that time arrives, however, we take it that the paper by Messrs. Michelson and Morley, in the current number of the *Phil. Mag.*, will be as interesting to electricians as it is now to the student of general physics. The writers describe a research undertaken in order to examine the question whether or not the assumption which is usually made that the ether (as a whole) is at rest in space would stand the test of experiment. The assumption is one which seems to an ordinary intelligence a very reasonable one, and, moreover, it has been shown by Fresnel that in order to complete the explanation of the aberration of light according to the undulatory theory as at present understood such an assumption is absolutely necessary. Nevertheless, the experimental evidence obtained by the writers referred completely upsets this view, and tends to show that upon or near the surface of the earth the ether moves onward with the same velocity as the earth in its orbit. It must be admitted that the result is an extraordinary one, and difficult of interpretation; for if the ether in the neighbourhood of the earth is carried onward with the same velocity as the earth itself, it would appear that something corresponding to a shearing stress would be set up in the medium. This makes things more complicated than ever.

Telephony has hitherto been a plant of slow growth in the West of England. The "Three-Towns," as they call themselves, of Plymouth, Devonport, and Stonehouse, embrace a population considerably exceeding 150,000, and yet a local journal finds it a subject for congratulation that there are now "no less than 202 subscribers" on the local telephone exchange. This stagnation has, in part, been the result of a prolonged dispute between the Post Office and the Telephone Company, in which, whatever may have been the merits of the original quarrel, the Post Office has got so much the worst of it that its own exchange, started in 1881, now drags out a lingering existence on a list of 12 subscribers! The Western Counties and South Wales Telephone Company commenced operations in 1884, three years later than the Post Office, and adopted a broad and liberal policy towards their subscribers, which is, in fact, characteristic of this company. The chief cause of the lack of success of the Post Office Exchange arose from the persistent and (to an outsider) the utterly unaccountable refusal of the Department to open telephonic communication between Plymouth and Devonport. It would be really interesting to know for what possible reason the Post Office found itself unable to accede to the repeated requests for this extension. That the improvement was, nevertheless, sooner or later, inevitable must have been obvious to all concerned However, we take it that should the Department ever undertake a more extended responsibility for the telephonic communication of this country, they would see their way to adopt a wiser and more liberal policy than that which has characterised their conduct at Plymouth.

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THE recent rise in the price of United Telephone Stock has been due to rumours of an approaching re-amalgamation of the provincial systems with the parent company.

Two or three suggestive articles have lately appeared in the *St. James's Gazette* on "Telephone Rates and Renters," chiefly directed against the rates which prevail in the metropolis. The writer's arguments and figures are not always convincing; but there is one point on which we have ourselves commented in these pages with regard to the London telephone service, and which the *St. James's* puts with some force, namely, that the area being so vast it might be cut up into districts, with a lower initial charge and extra fee when the renter wishes to go beyond the one in which he is located. A division of this kind would not be attended by serious difficulty, inasmuch as the experience of the United Telephone Company shows already that a considerable percentage of the total number of communications takes place through wires connected with the same switch room, of which there are now no less than twenty-four in different parts of the metropolis.

THE writer enforces his argument for reduction of telephone rents in London by reference to other towns, notably in Scotland. But the rent in Paisley is the same—namely, £10—as in Aberdeen; yet the proportion of renters to population is more than two-and-a-half times greater in the latter than in the first-named place. Besides, look at America, where the rents are universally higher and the users far more numerous than anywhere else. There must be other reasons to account for the diversity on which the writer has built up his theory. One of these reasons—in London, at all events—is the existence of a local system of Post Office Telegraphs, a system which is certainly largely patronised by the inhabitants, the increase of telegrams in the metropolitan area under the sixpenny rate being far in excess of the normal increase for the rest of the country. It is, perhaps, neither expedient nor possible for the United Company to extinguish this local telegraph traffic by telephony.

So long as there is a good service the public will not care much whether it is performed by a telephone company or the Post Office. There is one passage, however, in the *St. James's* Saturday's article which indicates a gradual obliteration of the distinction between telephony and telegraphy. When we remember that each one of the provincial telephone companies provides the majority of its subscribers with a more or less extensive system of trunk lines, by which for a small extra charge they may communicate not only with the towns in the immediate neighbourhood, but also in many cases with places distant 100 miles and more, it is apparent that the competition of the telephone with the telegraph is already of a formidable character. We have here an explanation of the loss, or at all events relative slowness of gain, which the Post Office Telegraphs are manifestly sustaining. And, perhaps, it will now be admitted that they were technically, as well as commercially, right who maintained from the first that a telephone system is a telegraph system. No wonder the Post Office regard this extension of the telephone with misgivings, and perhaps with alarm.

THE paper read by Dr. Shettle at the Physical Society on Saturday last (of which some account will be found in another column) contained a compendium of the views of the learned Doctor on the subject of a "supposed new force." Inasmuch as the experiments which have led Dr. Shettle to the conclusion which he now holds were originally set forth in the columns of this journal, it may be as well if we state very briefly what is at present our own view of the question. It is impossible to deny that these experiments have been conducted with conscientious accuracy and with very considerable manipulative skill, and it is therefore to ourselves a matter of sincere regret that we are obliged to arrive at the conclusion that Dr. Shettle has overlooked a very simple explanation which lies at the bottom of the phenomenon which he has been so diligently examining, and which, if recognised earlier, would probably have led him to the conclusion that there was, after all, little or nothing to be learnt by an elaborate course of detailed experiments of this nature.

THE whole argument can be put in a nutshell. Dr. Shettle takes a sphere of some insulating material, he winds it round with copper wire, and suspends it very delicately in front of the pole of an electro magnet. In different experiments the winding is done in various and elaborate forms, but—and here lies the whole secret—*the ends of the wire are always joined so as to form a closed circuit.* Now, when the current is switched on to the electro magnet Dr. Shettle observes a movement in the suspended sphere, and it is the nature and extent of these movements which he has been diligently investigating. But it is very difficult to see where the necessity for a "new force" comes in. The motion takes place during the incipient stage, while the magnetisation is growing, and therefore the closed circuit suspended in front of the pole of the magnet is cut by an increasing number of lines of force, with the necessary consequence that an induced current traverses the wire, and then the reaction of the resultant magnetic field of the coil upon that of the magnet itself determines a deflection or rotation of the sphere.

A MEMBER of the Physical Society writes to us on the same subject. The following is a portion of his remarks:—"Some of Dr. Shettle's spheres were solid, and others formed of a large quantity of copper wire wound on small wooden spheres in a fearful and wonderful manner; but it is quite clear that the manner of winding would have no effect upon the general character of the action. The method of winding was intended to illustrate some theories of Dr. Shettle's, which, we fear, were quite outside the comprehension of the members of the society, who for the most part labour under the disadvantage of having undergone a scientific training, which would naturally unfit them for following the author in his airy flights through the regions of imagination, not of the nature called scientific, but of a higher and more transcendental kind, untrammelled by anything so earthly as facts, and which explain to his more unfettered mind all the physical pro-

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blems of the universe, from the movement of a planet in its orbit to the ascent of sap in a dandelion."

Some surprise appears to have been occasioned by the line we have taken on the Fire Office Rules relating to electric lighting. We beg to state that the line in question is a very innocent one, and leads directly to a quite inoffensive termination—namely, the establishment and enforcement of one set of rules which shall deserve and command general acceptance. One set already does exist, and has not been seriously objected to in any public manner that we are aware of. No doubt the Council has excellent reasons for the course it now appears to have been following; but it can have none for complaining that technical journals, failing authoritative information, have adopted a line not exactly identical with that pursued by the Society.

When an alternating current is passed through a voltmeter it is obvious that, if the periodic time be gradually lengthened, we should at length arrive at a point where the liberation of gas would commence. The observation of the value of this period under given conditions of temperature and pressure, for different electrolytes, would almost certainly lead to results of some importance in the theory of electrolysis. Very probably this question has already received the attention of the members of the Electrolysis Committee of the British Association, but if not, we venture respectfully to commend it to their consideration.

The question has also a practical bearing, for it is a fact well known to many users of alternating current machines that a liberation of the mixed gases sometimes takes place when a water resistance is traversed by an alternating current. The action, moreover, takes place equally at both electrodes, and has been observed under a periodic time at least as small as $\frac{1}{60}$th sec. (3,600 alternations per minute). The result is rendered more obscure by the fact that it is by no means constantly apparent, even under what appear to be the same conditions. We believe, however, that there is some reason to suppose that it is dependent on the E.M.F. as well as the rate of alternation.

Since writing the above Note we learn that there is actually in existence—and in fact in use on a small scale—an alternating current meter based upon electrolytic decomposition. We understand that the instrument has every prospect of being a highly successful one, but at present it is not wished to make public the precise method of action.

According to Mr. J. M. Cattel, psychologists can now by the aid of electricity determine the time taken up by our mental processes, or "The Time it takes to Think," which is the title of his article on this subject in the current number of the *Nineteenth Century*. By the well-known device of causing a tuning-fork vibrating at the rate of, say, five hundred times a second to record its movements in a wavy line on a rapidly revolving drum, each undulation may be made long enough to be divided into twenty equal parts, and thus time can be measured to the ten-thousandth part of a second. Adapting an electrical current under the experimenter's control to this device the time elapsing between a sense-stimulus and the identification of it can be measured with great exactness. Thirty-five years ago Du Bois-Reymond succeeded in proving that this interval was less than ·001 second. But that this is timing "thought" we take leave to doubt; in most of the instances given it is the interval between perception and reaction, simple or complex, that is measured. But the experiments do seem to prove that thought is a comparatively slow process, and that to say "as quick as thought" is not saying much for the quickness. Electricity is infinitely quicker, and has the further merit of actually going whither we list, while our thought is only thinking about going.

Offenburg.—A local company has been formed at Offenburg for the supply of electric light.

A German Magnetic Observatory.—It is intended to establish a magnetic observatory in the neighbourhood of the existing astronomical observatory near Potsdam.

The West Indian Cables.—Telegraphic communication with the Island of Antigua, which has recently been interrupted, is now restored. The cable between Trinidad and Demerara is still interrupted.

"The Management of Accumulators."—We have received from Messrs. Whittaker and Co. a copy of the third edition, revised and enlarged, of Sir David Salomons' work on "The Management of Accumulators."

Utilisation of the Treadmill.—According to the *Daily News* the prison authorities have decided to consult the electrical engineering profession as to the possibility of utilising the treadmill power which at present is allowed to waste.

Award.—We are glad to learn that Messrs. Woodhouse and Rawson (Limited), of 11, Queen Victoria-street, have been awarded the First Order of Merit for their exhibition of electrical fittings and appliances at the Exhibition now being held at Adelaide.

The German Cables.—A Berlin telegram of Tuesday last states that the Bill for the purchase, by the State, of the present telegraph cables between Germany and England will be brought forward in a few days. The expense of the transfer is reckoned at about seven millions of marks. Immediately after the nationalisation the Anglo-German tariff will be considerably reduced.

Elberfeld.—The installation undertaken by the Municipality of this town commenced working a few days since. It has been carried out on the Edison three-wire system, and at present does not absorb more than 120 horse-power. Aron meters are in use, and a special form of this instrument has been designed to meet those cases in which a single installation is connected with both sides of the main circuit.

Country House Lighting.—We learn that Benacre Hall has recently been supplied with electric light, the installation having been carried out by Messrs. J. Edmundson and Co. The dynamo is driven by an engine of eight horse-power nominal, capable of working a hundred 16 candle-power lamps. An accumulator capable of supplying seventy-five lamps of 16 candle-power for nine or ten hours has also been supplied.

Leamington.—We are glad to learn that the Leamington installation is making steady progress, and that up to the present time everything continues to work satisfactorily. We make this announcement in view of the fact that a rumour to the effect

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that difficulties had arisen with the Corporation has been in circulation, but on inquiry we are assured that this statement is entirely without foundation, and that all is going on well.

The Atlantic Cable "Pool."—Action in France.—A Paris telegram states that the action brought by the Anglo-American Telegraph Company against the Transatlantic Cable Company for breaking away from the other companies in the "pool" came on before the Tribunal of Commerce on Tuesday. The case, says the *Central News*, is an important one, as testing the binding nature of the agreement, and on the French side it was contended that the whole arrangement was an illegal one. After hearing the arguments on both sides, it was announced that judgment would be given on the 17th inst.

Telephone versus Speaking Tubes.—Telephones are now coming into use as a substitute for speaking tubes in large buildings. The Equitable Telephone Association (Limited) has just completed an installation of six instruments at 27, London-wall, whereby all the different floors of the warehouse are put in direct communication with one another, and with the general and private offices. The same company has at present in hand a similar installation, with 27 telephones, in the new warehouse and offices of the Co-operative Wholesale Society (Limited), Leman-street, Whitechapel.

Weston-super-Mare Town Lighting.—The Weston-super-Mare Local Board invite tenders for lighting their district with electric light. Tenders to state price for lighting, providing, fixing, and keeping in thorough order and repair all wires, posts, &c., connected with the lighting of sixty lights, 1,200 candle-power, averaging six hours per day, ditto seven hours, ditto eight hours, at per light per annum, for three, five, and seven years respectively, also (same number of lamps and candle-power) per hour, for the respective periods of three, five, and seven years. Sealed tenders to be sent to Mr. W. Smith, clerk, Town Hall, Weston-super-Mare, endorsed "Tender for Lighting," by 19th inst.

Fire at Messrs. Johnson and Phillips's Factory.—We regret to record that early on Wednesday morning a fire, which rapidly assumed serious proportions, broke out in Messrs. Johnson and Phillips's factory at Victoria-road, Charlton. The factory consists of a number of detached buildings, and by the exertions of the fire brigade the damage was confined to the workshop in which it broke out; but this building, with the valuable machinery which it contained, was almost completely destroyed. Messrs. Johnson and Phillips request us to make known that the conduct of their business has not been in any way interfered with by this accident, and they will be enabled to execute orders with as much promptitude as before.

Lighting of the Royal Albert Hall.—The lighting of the Albert Hall has hitherto been effected solely by means of a double row of gas jets placed around the base of the dome. As many of our readers will be aware, these jets were lighted by means of a large induction coil apparatus, supplied, if we mistake not, by Messrs. Apps. It was recently decided, however, to introduce electric lighting for the lower portion of the hall, and the three tiers of private boxes have been encircled with incandescent lamps; but it was then found that the orchestra became so dark by comparison that it has been decided to place additional lamps depending from the ceiling over the platform. The work is being carried out by the Anglo-American Brush Company.

The Fouling of Ships.—At the Royal United Service Institution Mr. C. F. Henwood recently read a paper on a matter of vast importance, both in relation to our ships of war and the mercantile marine—namely, the corrosion and fouling of the bottoms of iron and steel ships. Mr. Henwood advocated the use of zinc as a sheathing, which, even as hitherto imperfectly applied, tends to preserve the iron or steel from corrosion in sea water, and in certain cases from fouling. He "considered that it might be fairly and reasonably assumed that zinc-sheathing, if applied so that the electro-positive zinc was in contact with the electro-negative iron or steel, the zinc would be perpetually dissolving away in an oxide, and carry with it the barnacles and other zoophytes, leaving a clean surface."

The Phonograph.—The announcement of the fact that Edison has lately perfected his phonograph, has naturally led to a host of rival inventions. Of these, the most noteworthy are those of Prof. Graham Bell and of Mr. Berliner. All these are purely mechanical appliances; but in the phonograph of Mr. R. M. Hunter the aid of electricity is secured. Mr. Hunter takes a trace on a sheet of specially prepared carbon paper, and the instrument repeats the words through a telephone receiver, by means which will readily suggest themselves to the electrician. It is thus inferior to the Edison apparatus in the loudness with which the tones are reproduced.—We have been interested to learn that Colonel Gouraud, who is a personal friend of Edison's, will in a few weeks enter into regular phonographic correspondence with him. The arrival in this country of Edison's first phonogram will naturally be looked for with considerable interest.

Prize Essay.—We learn from *L'Elettricita* that the Italian Society for the Advancement of Electrical Science and its Practical Applications has offered a gold medal of the value of about £30 for the best memoir on electro-magnets, from the point of view of affording practical guidance in determining the best forms and dimensions for the field-magnets of a dynamo. The memoirs are to be written in French or Italian, and to be sent to the Executive Committee before the 30th October, 1888, each memoir to be inscribed with a motto and accompanied by a sealed envelope bearing the same motto on the exterior, and containing the author's name and address. The competition is to be open to all comers, and the society is to have the right of printing an edition of 1,000 copies of the successful memoir, of which 100 will be sent to the author, who will retain the right of issuing further editions. The unsuccessful memoirs will be retained in the possession of the society.

Electricity versus Gas.—A firm in Brussels which has been using the electric light for the last twelve months as a substitute for gas in their spinning mills shows the following comparative statement of cost in the two cases:—

Gas (previous year).

	£	s.	d.
360 burners, 123 litres each, at 18 centimes per cubic metre, cost per hour 7·97fr. (6s. 3d.).			
857 hours per annum, at 6s. 3d. per hour	£273	3	4
Maintenance	24	0	0
	£297	3	4

Electricity.

	£	s.	d.
Carbons, consumption per lamp hour = 44 centimes			
36 lamps for 857 hours = 1,357·5fr.	£54	6	0
Interest and depreciation, 12 per cent. upon 15,000fr. = 1,800fr.	72	0	0
Maintenance, &c.	14	0	0
Coal	10	1	0
Extra coal for warming the building	8	1	0
	£158	8	0

Balance in favour of electricity, £138. 15s. 4d.

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The Government and the Submarine Telegraph.—A Dover correspondent of *The Times* states that, in anticipation of the taking over of the submarine telegraph, the postal authorities are actively engaged in perfecting and improving the means of communication between the central office in London and the shore end of the cable which crosses the Straits of Dover. The plans for the new arrangements will occupy the attention of the staff throughout the year 1888, at the end of which period the cable will be taken over. During the last few winters some very serious delays have taken place in the transmission of messages owing to the damage occasioned to the wires during severe weather. With a view to prevent the occurrence of these delays as far as possible, the postal authorities are having insulated wires placed in tubes underground at all notably weak points on the line between Dover and London. The submarine wires, which are connected with the cable at St. Margaret's Bay, and which have hitherto been run into Dover from the cliffs on poles, have all been replaced in tubes in this way, and carried as far as Dover central post office, through which Continental messages will be transmitted. Provision has been made for increase of business by the laying down of several additional wires.

Theatre Lighting.—At a recent meeting of the Royal Institute of British Architects a paper was read by Mr. Ralph Nevill, F.S.A., on "The Auditorium of a Theatre." The following are Mr. Nevill's views as to lighting:—"Lighting ought to be regarded by the manager as a potent means of inspiriting an audience. It might be accepted that the electric light would be used, but nevertheless provision must be made for gas. To be successful artistically the light must be various. In the event of fire the electric light would be extinguished; the gas sunlight ought therefore never to be put out, but turned low during the performance, and turned up full between the acts, the electric light being turned quite out in the first case, so that the eye was entirely drawn to the stage. The front of the circles was the natural place for electric lights. The electric light rendered no great provision of fresh air necessary during a performance. It would, however, be always requisite to provide an exit for impure air; and as long as gas was used behind the scenes, there must be sufficient ventilation to take away the enormous and dangerous heat at the top, without creating a draught to the stage. At the present moment the question of fire risks was that which was of most interest in connection with theatres, and after deprecating more than a certain degree of legislation and State interference, the author expressed his belief that in London, in a well-regulated theatre, fire risks were of the slightest."

Physical Society of Glasgow University.—The Gray-Milne Seismograph.—A meeting of the above society was held on the 9th inst. in Mr. James White's Scientific Instrument Factory, at Glasgow, Mr. Magnus Maclean, president, in the chair. Mr. Thomas Gray exhibited and described an improved form of the Gray-Milne Seismograph. This is an apparatus designed to record the various motions of the earth at a point on its surface during the transit of an earthquake, together with the time at which the motions take place, and their period. The motions are recorded in ink on a band of paper in the form of three components, one vertical and two horizontal, at right angles to each other. The band of paper is kept continually moving forward at a very slow rate, and marks are made upon it at equal intervals of time by means of a pen actuated by a separate clock. An automatic apparatus is provided which, at the time of an earthquake, greatly increases the speed of the paper feed, and thus allows the different motions of the earth to be clearly separated. The same automatic apparatus also brings into action mechanism for recording much shorter intervals of time on the paper during its transition from slow to quick speed. After a short interval the speed is changed back to slow, and the automatic apparatus readjusted by the clockwork itself. The apparatus is capable of recording any number of successive earthquakes which may take place during a week without adjustment by the observer. At the same meeting Mr. T. A. B. Carver explained a quick method of photography, which has also the advantage of allowing prints to be taken by gaslight. He illustrated the method by photographing the seismograph, the negative being taken by magnesium light, and the prints by gaslight.

Technical Education Conference.—On Wednesday evening a conference on technical education was held in the Royal Victoria Hall, Waterloo Bridge-road, for the purpose of enabling the employers and workmen of the neighbourhood to meet and discuss the subject from their several points of view, especially with regard to probable legislation. Sir Henry Doulton presided, and letters of regret for non-attendance were read by Mr. Charles Morley from the Marquis of Ripon, Sir Frederick Abel, the Dean of Westminster, the Bishop of London, Sir Ughtred Kay-Shuttleworth, Prof. Seeley, Mr. George Howell, M.P., Mr. Mundella, M.P., and others. The Chairman said that the technical education movement was now absorbing the attention of the English people. John Bull had been sound asleep, but he had woke up with a start. England must maintain her industrial supremacy, which was being challenged on all hands. All that the Government could do, all that great corporations could do, and all that individual energy could do, must be done. A better kind of manual teaching was undoubtedly required in our primary schools.—Mr. Bockett (a working man) then read a paper on the question before the meeting. From the recent Parliamentary Bills, he said, it was clear that the legislators on both sides of the House only felt strong enough to tinker with the subject. He thought genuine trade guilds should be formed in order to start technical schools, to be managed by a mixed committee of employers and workers. These guilds would not do away with the necessity for apprenticeship.—Another paper was read by Dr. J. Fleming, who said that the country should be covered with evening classes, and there should be a multiplication of such colleges as that at Finsbury. A discussion then ensued, among those who took part in it being Mr. H. Cunynghame and Mr. Bartley, M.P. Dr. Lant Carpenter moved, and Mr. John Ward (a working man) seconded, the following resolution:—"That this meeting desires to express its strong opinion of the urgent need, not merely of a well-considered scheme of technical education, but of such preparatory educational measures as will render that system of the greatest possible service." Dr. Carpenter said that the discussion would be resumed at a further conference, to be held early next year. The resolution was carried unanimously.

The "Sun" Portable Electric Lamp.—*The Times* of 13th December contains the following:—"A new form of portable electric lamp has just been brought under our notice, the primary object of the inventor, Mr. Urquhart, being to utilise it as a miners' lamp. It is, however, said to be equally applicable for domestic and every other class of electric lighting. As a miner's lamp it weighs 4lb. 2oz. and gives a good all round light for ten hours. It is a modified form of secondary battery, and possesses the great advantage over other batteries of that class that it can be fully charged with a ten hours' supply of current in four hours. The

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cell or casing is 6in. high and 3½in. in diameter, and has a small glow lamp of 1¼ candle-power mounted on the top. The positive element is zinc, of which there are two plates, the negative element being a plate of special metallic alloy. These elements are suspended in a depolarising solution of dilute sulphuric acid mixed in the proportion of 10 to 1. The battery can be used as a primary, but is at its best as a secondary battery, charged from a dynamo in the usual way. The cost of the miners' lamp is stated to be one guinea, and the cost of maintenance 3d. for six shifts of ten hours each. There is no waste going on while the lamp is not running, although the elements remain suspended in the solution. The case is strongly bound with metal and the glow lamp is protected first by a toughened glass dome, and secondly by a cage of stout brass wire. Absolute safety against risk of explosion, should the glow lamp glass be broken, is insured by an ingenious automatic contrivance in connection with the toughened glass dome. Should this dome be fractured the circuit is broken and the light is instantly extinguished whether or not the glass of the glow lamp be broken. The lamp is being introduced by the New Portable Electric Lamp and Power Syndicate, who have had some of the lamps tried at the Dukinfield Colliery, near Manchester, with every success. This lamp, among others, was exhibited at the reading of Sir Frederick Abel's recent paper on mine accidents, and met with commendation from him. Since that time, in order to test it for safety in a thoroughly practical way, some lamps were placed in the hands of Mr. C. E. Rhodes, the manager of Aldwarke Colliery, Rotherham, who states that he is much pleased with them, the light given being equal to four of the best oil lamps."

Prof. Ewing's Lectures on Electric Lighting.—On Monday evening last Prof. Ewing, at Dundee, brought his course of popular lectures on Electric Lighting to a close, the subject of the final lecture being the cost of electric lighting for factories and domestic purposes. Taking the case of a factory, where the necessary engine power was already provided, he said that the first cost of the whole electric plant, including dynamo, wiring, lamps, and fittings, was a little less than £2 per lamp, provided the number of lamps was over 200. He then considered in detail the cost of lighting a factory with 400 lamps. The first cost of the electric plant was £800, which represented an annual charge of, say, £88 on account of interest and depreciation. The current outlay for coal, oil, and lamp renewals was considered in detail, and shown to be about 2s. for each hour that the lamps were in use. If the lamps were only used for a small number of hours in the year the whole working cost was high, because the charge for interest and depreciation had to be spread over that small number of hours; but if the number of hours in use was large electricity was found to be much cheaper than gas. There was a particular number of hours of annual lighting which made the cost of electricity just equal to that of gas. This number was 425 hours. Hence, if a mill worked only by day there was little or no direct economy (though there were other advantages) in the use of electric lamps as compared with an equal number of gas burners; but if night work was done there was a very distinct economy. Thus, if the 400 lamps were needed for 3,000 hours in the year, the whole annual cost of lighting by electricity would be £388, as against £918 for gas. The lecturer went on to speak of the cost of domestic lighting, and pointed out that it was very great where each householder had to supply his own electricity. By co-operation, however, it might be reduced to a more moderate figure, though it remained, and apparently would remain, for some time dearer than gas. The inhabitants of a square or terrace might combine, each agreeing to take a certain number of lamps at an annual rental. Taking an imaginary case, where 500 lamps were supplied in this way, all within a reasonable radius, and with sufficient storage capacity to supply night lamps when they might happen to be wanted, the lecturer found that the capital cost would be £2,200, and the annual charge, including interest and depreciation, would be £625. Thus the co-operative scheme would pay the expenses if people appreciated the advantage of electric lighting enough to pay 25s. per lamp as the annual rent. Particulars were given of the public installations in London, Brighton, Antwerp, Berlin, Hanover, Milan, Tours, and Vienna, where in the aggregate many thousands of lamps were in use. At these places the public were supplied with the electric light at a charge which was usually a little less than ½d. per lamp per hour.

The Formulæ of "Dimensions" in Electricity.—M. Lippmann, in a note in the *Comptes Rendus*, points out that the formulæ of "dimensions" in electricity affords a criterion of the maximum theoretical simplicity of any experimental method of measurement. In other words, the formula indicates the character of the measurement (of length, mass, or time) to be made, which is the necessary and sufficient condition for obtaining the numerical value of the quantity sought in absolute units. One or two examples will make this clear. (1) In absolute electrostatic units capacity has the dimensions of length. The principle which has been laid down leads, therefore, to the conclusion that there must be some, at least conceivable, method by which the capacity of a conductor could be determined in absolute units without the necessity for making any other than a single linear measurement; and this measurement must be numerically equal to the capacity sought. The following is M. Lippmann's solution. Suppose that we are required to determine the capacity of a Leyden jar. Imagine that we are provided with a metallic sphere whose radius can be varied continuously. We can then easily adjust the size of the sphere until its capacity is equal to that of the jar, and this can be done experimentally without requiring any operation of the nature of measurement. When, however, the adjustment has been effected, we know also that the capacity of the jar and the sphere, being equal, is measured in absolute units by the radius of the sphere. (2) Take the case of resistance, which has the same dimensions as velocity. M. Lippmann shows that it is possible to conceive a method of measuring resistance depending solely on the measurement of a velocity. Returning to the familiar though imaginary experiment in which a rectilinear conductor of unit length is supposed to move through a magnetic field of unit intensity in a direction at right angles both to itself and to the direction of the lines of force; we then say that if the slider form part of a circuit of unit resistance containing no other resistance than itself, unit current will flow through that circuit when the velocity of motion is equal to one centimetre per second. M. Lippmann now bowls over all these restrictions, and allows the experiment to take place with any length of slider, any resistance, and any magnetic field. He fixes attention, however, upon a point, P, situated at a constant distance from and in the rear of the slider, and in its plane, *this distance being equal to twice the length of the slider.* [It would seem that M. Lippmann exceeds here the limits which he assigns himself.] Now if a magnetic pole be placed at the point P, there will be a certain velocity of motion at which the magnetic field due to the current in the slider will at the point P exactly counterbalance the effect of the generating field, and consequently a small needle at this point would undergo no deflection. It can now easily be shown that the velocity of the slider is numerically equal to its resistance.

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SOME ENGLISH CENTRAL LIGHTING STATIONS.

I.—BRIGHTON.

(Continued from page 102.)

The Brighton Ammeter.

Mr. Wright has in use a very simple form of ammeter, in which the principle made use of is that of the repulsion of similar poles. It is obviously more easy to get a proportionate scale in an instrument based upon the principle of repulsion than upon that of attraction. In the former case, with small currents, the armature occupies the position where the rate of change of strength of field is greatest and the instrument is most sensitive; while the reverse is of course the case with instruments depending on attraction. This fact is so obvious that it can only be a matter for surprise that so little advantage has hitherto been taken of it by instrument makers. In the earlier (1884) type (Fig. 4) of this instrument a pair of solenoids are mounted one above the other, with their coils so connected that the cores are of similar polarity at either end.

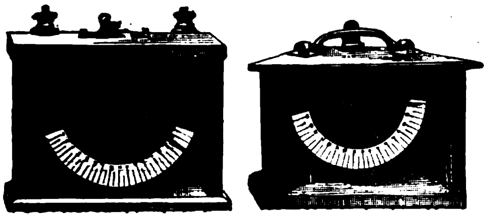

Fig. 5. Fig. 4.

The lower core is fixed, and is provided with a pole-piece bent upwards at right angles and then cut off obliquely as shown. The upper core is of the same shape, but is pivoted at either end, so that the horizontal portion is free to rotate on its own axis; the vertical portion carries an index needle and a counterbalance. The weight of the counterpoise and the shape of the pole-pieces are carefully adjusted, so that the deflections are nearly proportionate throughout the entire length of the scale, which extends over 140 degrees.

The next step obviously consists in placing both cores side by side within a single solenoid; this pattern (first made in 1885) is shown in Fig. 5. The chief, perhaps the only, defect in these instruments as continuous current ammeters lies in the variation of the reading between ascending and descending currents of the same value. This can, however, be obviated by making it a rule to short-circuit the instrument between any two readings.

The E.M.F. Recorders.

In Fig. 6 is seen the automatic apparatus by which the fluctuations of the E.M.F. are automatically registered from instant to instant. There are usually four recorders at work registering on separate circuits, and it is extremely interesting to watch their movements. The apparatus consists of a solenoid in series with a resistance of 80,000 ohms, and connected as a shunt to the mains. The solenoid is provided with a core which is attached to the bow-shaped spring seen on the right hand side. A light needle extends nearly at right angles to the top of the core, and presses obliquely against a sheet of carbon-coated paper, on which it leaves a trace. The paper is moved forward horizontally by the train of wheelwork seen on the left, which is really nothing more than the interior of a cheap American clock. A weight attached to a cord passing over a pulley keeps the paper taut at the other end. The needle moves up and down vertically with every variation of the E.M.F. A similar arrangement is employed to register the variations of the current, which should, of course, trace a perfectly straight line. The trace thus taken is examined every morning, and thus a record of the rate of expenditure of energy in the circuit at any moment may be obtained. Fig. 7 is a facsimile on a reduced scale of a trace taken from the E.M.F. recorders on four circuits (north, east, west, and north-east) on April 23rd, 1887. In the actual apparatus a variation of 100 volts moves the scriber 1 centimetre vertically, while the clockwork carries the paper horizontally at the rate of 2 centimetres per hour. The N circuit includes the railway station, where a large number of arc lamps are hung; this accounts for the greater irregularity of this trace, as all the movements of the feed leave their record.

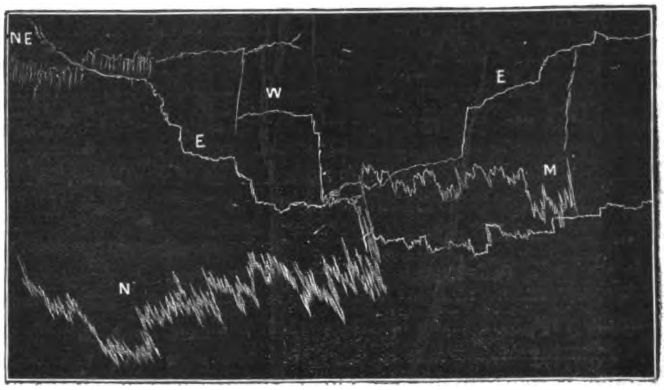

Fig. 7.

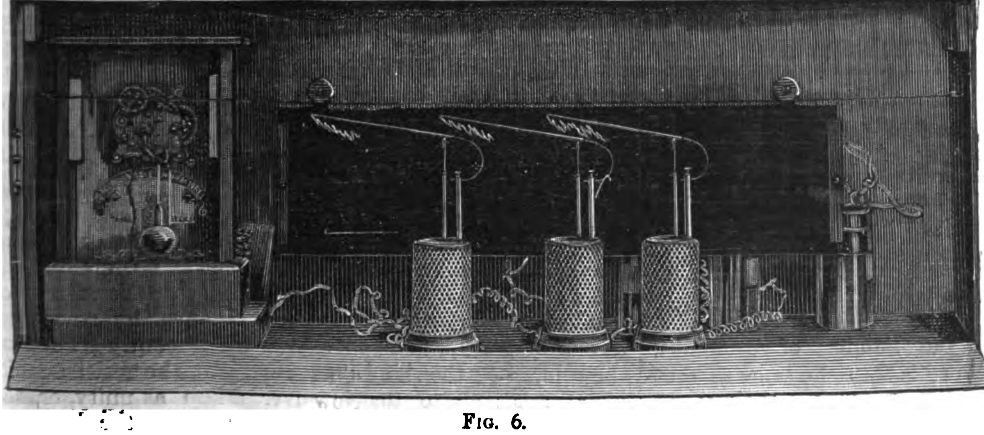

Fig. 6.

The Protectors.

In running incandescent lamps upon a constant current circuit, the "protector" necessarily forms a very important feature of the system. The object of this device is to ensure the safety of the remaining lamps upon a parallel in the event of any one lamp giving way. It is hardly necessary to remark that even when a lamp is placed *hors de combat* the full current must still traverse the parallel; the potential at the terminals of the remaining lamps therefore rises, so that if a second lamp should give way it is probable that the whole parallel would follow suit, and thus lead to a break down of the entire circuit. It should be mentioned that the "parallels" at Brighton consist either of (1) ten lamps taking 1 ampere each; (2) three lamps taking 3·5 amperes each; or (3) of one lamp taking the entire current and giving a light of 60 candle-power.

First Pattern.—The protector employed at Brighton in 1883 consisted of a series of electro-magnets equal in number to the lamps on the parallel placed in a row with their coils connected each with the terminals of a lamp. If any lamp broke, the cessation of current in the coils of its magnet released an armature which brought a spare lamp into circuit. Only one spare lamp was necessary, one of its terminals being connected to one side of the main circuit, and the other to a bar upon which any

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one of the armatures could make contact. This device fully answered its purpose, but it was obviously necessary to find something cheaper and equally efficient.

Second Pattern.—This was termed the Safety-holder, in which the cessation of current in a particular lamp caused the armature of an electro-magnet contained in this lamp-holder to make contact to a third wire leading to the safety lamp of the whole parallel. This reduced the number of wires it was necessary to run to 3, instead of 11, in a 10-light parallel.

Third Pattern.—In 1884 a far more economical arrangement was introduced, and is still in use. A single electro-magnet was connected as a high-resistance shunt to the parallel. Its armature was delicately adjusted, and on the increase of E.M.F. it closed a contact, and threw into the circuit a lamp of only half the normal resistance of the ordinary lamps. The armature, after falling, was held down by a mechanical or electrical catch. This is shown in Fig. 8. The switch is mounted on the same base.

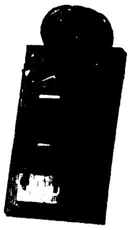

FIG. 8.

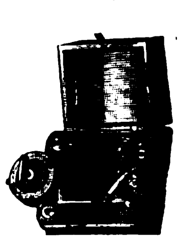

FIG. 9.

Fourth Pattern.—An additional refinement was introduced in 1885 by which, if a second lamp give out, the whole parallel is short-circuited. This is effected by causing the first contact which throws in the safety lamp to take place on a spring. If the E.M.F. again increase the armature closes more tightly, and brings the spring into contact with a terminal connected with the opposite side of the parallel, thus short-circuiting the whole set of lamps. This remedy is, of course, a somewhat drastic one, but it very seldom comes into operation, and in any case it is better to interrupt a single parallel than to break down the whole circuit. This form is shown in Fig. 9.

THE METER.

The consumers are charged by meter at the rate of 1s. per unit. Mr. Wright terms his apparatus the "Faraday" meter, as being based upon Faraday's discovery of the proportionality

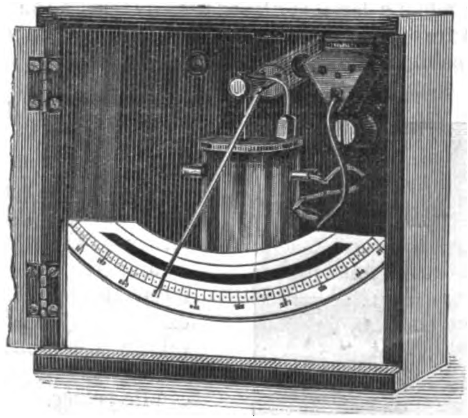

FIG. 10.

of electrolytic deposition with the number of coulombs. But although the principle employed is thus the same as that adopted by Edison in his well-known meter, yet the method of application is entirely different, and is capable of yielding far more accurate results. Edison calculates the total consumption of current by passing a known (or supposed known) fraction of the total current through the meter, and the energy supplied is calculated on the assumption that the difference of potential is constant throughout the circuit. This assumption is, of course, only approximately correct. These objections to the electrolytic method are absent when it is employed in connection with a constant current distribution. In the first place we have now to measure the "volt-hours" across the terminals of the house connections, so that the meter is a shunt to the whole installation. By placing a high resistance in circuit with the meter in order to reduce the current in the shunt circuit, no error is introduced. Secondly, by integrating the E.M.F. and assuming constant current we are introducing no non-existent factor; in fact, as we have already seen, the current at Brighton is actually maintained constant within 1 per cent.

The meter employed is shown in Fig. 10. It consists of a small glass jar containing sulphate of copper solution, with a pair of copper electrodes. This is placed in series with a resistance of several hundred ohms, made up of bare G. S. wire strung on a small wooden frame. The cathode is attached to a rod, which is bent over and pivoted at the top, and carries a weight at its extremity. The arrangement is such that as copper is deposited on from the plate the counter-balancing weight gradually rises and the pointer traverses the scale, the arm being so hung that it is in stable equilibrium in all positions. In practice it is found that the employment of an index hand which can be read as easily as a gasmeter is much appreciated by the consumers.

(To be continued.)

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

By A. E. KENNELLY, Electrician, Eastern Telegraph Company.

(Continued from page 78.)

CHAPTER IV.

Resistance.

29. We have already seen (*see* para 14) that the resistance of any electric path is the obstruction which a current traversing it encounters, and we are now in a position to examine the nature of this obstruction more closely.

30. Of all known substances metals offer the lowest resistances, and the more common of these may again be comparatively classed in the following list, which commences with the least resisting and ends with the most resisting metal:—

Relative Specific Conductivity.		Relative Specific Resistance.
1·000	Silver (hard drawn)	1·000
0 996	Copper „ „	1·005
0·780	Gold „ „	1·283
0 290	Zinc (pressed)	3·446
0·168	Iron (annealed)	5·949
0·131	Nickel „	7·628
0·124	Tin (pressed)	8·091
0·083	Lead „	12·131
0·046	Antimony „	21·645
0·016	Mercury (liquid)	62·500
0·0125	Bismuth (pressed)	80·000

Since in this list, taken from Clark and Sabine's tables silver is the metal offering least resistance to a traversing current, it must also be the metal which most facilitates its passage—that is to say, which conducts it best. Silver is therefore said to be the metal of greatest *conductivity*. The table therefore gives the metals in diminishing order of resistance by ascent, and in diminishing order of conductivity by descent. The figures in the column on the right hand represent the resistance of each metal relatively to that of silver taken as unity, or, as it is called, the *relative specific resistance*; while the figures in the left hand column give the conductivity of each metal relatively also to that of silver as standard, or, as it is termed, the *relative specific conductivity*. Thus iron is shown to have a resistance of nearly six times that of silver, so that if a conductor made of pure hard-drawn silver were of such dimensions as to offer

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resistance of one ohm, a conductor of annealed iron of exactly the same dimensions would offer about six ohms. Consequently, since iron resists a current six times as much as silver, the conductivity of silver must be six times that of iron; therefore, calling the conductivity of silver 1, that of iron must be six times less, or one divided by six—that is, $\frac{1}{6}$, or 0·167, the more exact number being by the table 0·168 $=\frac{1}{5·949}$. Similarly, the relative specific resistance of mercury being 62·5, its relatively specific conductivity is $\frac{1}{62·5}$, or 0·016—that is to say, 1·6 per cent. of pure silver; so that in all cases the specific conductivity of any material relatively to a standard material is the quotient found by dividing into unity the specific resistance of the substance relatively to the same material; and, further, the conductivity of any path is found from the resistance of that path in the same manner and is expressed in terms of a unit, to which the name of *mho* has been given by Sir William Thomson, the term conveying the inverse idea of resistance by being an inversion of the word ohm. Thus, if a certain conductor had a resistance of 0·2, 1, 50, or 7,000 ohms, its conductivity would be $\frac{1}{0·2}$, $\frac{1}{1}$, $\frac{1}{50}$, or $\frac{1}{7,000}$ mhos respectively, that is, 5, 1, 0·02, or 0·000143 mhos.

31. The relative specific conductivity of metals is always reduced by impurity, and even a very slight degree of impurity will suffice to palpably lower the conductivity, or, in other words, add to the conductor's resistance. It is by no means impossible to find a sample of impure commercial copper which will only possess the specific conductivity of zinc, owing to the admixture of foreign and non-conducting material, or of baser and more resisting metal. Also a conductor composed of an alloy of different pure metals in known proportions has generally a greater specific resistance than would be furnished by an estimate made on the supposition of its being a bundle of separate and purely metallic conductors of proportional dimensions.

32. The table also shows that pure copper is so close to pure silver in conductivity as to scarcely make it desirable to select the latter and rarer metal for conductors, even were the matter of cost entirely set aside. In telegraphy, therefore, copper is the metal employed as the conductor for submarine and subterranean purposes, while both iron and copper are used for overhead wires.

33. The resistance of a conductor of homogeneous materiel depends only upon its dimensions and temperature. So that if the temperature of a fixed conductor be constant, its resistance will be the same to every strength of current.

34. As regards dimensions, the resistance of a conductor of homogeneous material depends upon its cross-section and length. If its cross-section be constant, the resistance will be proportional to the length. Thus, if a mile of a certain wire had a resistance of 10 ohms, then the resistance of 0·02, 0·4, 7, or 5,000 miles of the same material and cross-section would be 0·2, 4, 70, or 50,000 ohms respectively.

35. With conductors of the same length and material, the resistance increases as the cross-section is reduced, just as the resistance to the flow of water through a pipe is increased as the pipe is reduced in cross-section. Thus, if two wires, A and B, are of the same length and material, but B has twice the cross-sectional area of A, then B may be regarded as being made up of two wires very close together each of A's cross-section, and therefore equal to A in every respect. Obviously the double wire would convey under the same E.M.F. double the current that would traverse the single wire A, and its conductivity, being double its resistance, would be only half that of A. Similarly, another wire, C, of the same length and material, but of three times A's sectional area, would offer one-third of A's resistance; and in the same way if C had 0·25, 0·7, 3, or 15 times the cross sectional area of A, it would offer $\frac{1}{0·25}$, $\frac{1}{0·7}$, $\frac{1}{3}$, or $\frac{1}{15}$; that is 4, 1·43, 0·33, or 0·061 times A's resistance respectively.

36. Further, since in doubling the sectional area of a given length of homogeneous wire we double the quantity of metal in it, we necessarily double the weight of the wire, so in every case the conductivity of a wire of fixed length and material will be proportional to its weight. Thus, if a wire, A, one mile long, weighing 100lb., offers 10 ohms resistance, then another wire, B, of the same material, one mile long, and weighing 200lb., would have double the cross sectional area, double the conductivity, and consequently half the resistance of A, namely, 5 ohms; and in the same way if B were to weigh 0·5lb., 2lb., or 500lb., it would offer $\frac{100}{0·5}$, $\frac{100}{2}$, or $\frac{100}{500}$ times, that is 200, 50, or 0·2 times the resistance of A respectively.

37. The conductors employed in telegraphy are wires, that is to say, are cylindrical in form, so that their dimensions are generally (1) length (on land in statute miles of 1,760 yards, at sea in nautical miles of 2,029 yards), and (2) either the diameter or the weight per mile. If the diameter is given, the sectional area is found by multiplying the square of the diameter by 0·7854. For example, a wire 0·03in. in diameter would have a sectional area of 0·03 × 0·03 × 0·7854, or 0·00071 square inch. The sectional area and weight of a wire are directly connected, for in the case of iron wire the sectional area in square inches multiplied by 17,500 gives approximately the weight in pounds per statute mile. For copper wire the similar multiplier is 20,000, but for cable core whose conductor is usually a strand of seven copper wires, the approximate weight of conductor per nautical mile is found by multiplying the sectional area found from the diameter as above by 18,100. For example, a copper strand of cable core has a diameter of 0·13in. Its area will therefore be approximately 0·13 × 0·13 × 0·7854 or 0·01327 square inch, and 0·01327 multiplied by 18,100 gives 240·2, the approximate weight in pounds of one nautical mile of this strand.

38. The problems which practically arise for solution in the case of telegraphic conductors are generally of the following form:—Having given the metal of which a wire is made, and any two of the three following particulars—dimensions, resistance, and conductivity relatively to pure metal, it is required to find the third. Leaving the effect of temperature at present out of consideration—that is to say, supposing that the temperature remains constant—we shall find no difficulty in solving any such problem, as the following cases will show:—

(*a*) Having given the dimensions and resistance, to find the conductivity.

Example.—A copper strand conductor of cable core 5 knots long and 0·096in. in diameter gives a resistance at the standard temperature of 48·42 ohms. What is its conductivity compared with pure copper?

The sectional area of the strand is 0·096 × 0·096 × 0·7854, or 0·007238 square inch approximately. Its weight per knot is therefore 0·007238 × 18,100, or 131lb. As may be seen in electrical tables, the resistance of a wire of pure copper one knot (nautical mile) long, and weighing altogether 1lb., would be 1196·7 ohms at the standard temperature of 75° F.; consequently, the resistance of a wire of pure copper one knot long and weighing 131lb. would be (36) at the standard temperature $\frac{1196·7}{131}$, or 9·135 ohms, and hence its conductivity would be $\frac{1}{9·135}$ mho, that is 0·10947 mho. The wire in question offering 48·42 ohms is five knots long, so that one knot would offer $\frac{48·42}{5}$, or 9·684 ohms, and the conductivity of one knot would therefore be $\frac{1}{9·684}$, or 0·10326 mho. The conductivity of pure copper is to the conductivity of this wire, therefore, in the proportion of 0·10947 mho to 0·10326 mho

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—that is, as 1 is to 0·9433, or as 100 : 94·33; so that the wire's conductivity is thus $94\frac{1}{3}$ per cent. that of pure copper.

(*b*) Having given the dimensions and conductivity, to find the resistance.

Example.—A copper wire 600 yards long and 0·25in. in diameter has a conductivity 96 per cent. that of pure copper. What will be its resistance at the standard temperature?

The sectional area is in this case of a cylindrical wire, not a strand, strictly 0·25 × 0·25 × 0·7854, or 0·0490 square inch, so that its weight per statute mile will be 0·049 × 20,000, or 980lb. approximately. The resistance of a statute mile of pure copper weighing one pound may be seen in electrical tables to be 872 ohms at the standard temperature, which for overhead land lines is generally taken at 60° F. A wire of pure copper weighing 980lb. per mile would therefore have a resistance of $\frac{872}{980}$, or 0·8898 ohm, and its conductivity will thus be $\frac{1}{0·8898}$, that is, 1·1238 mho; but its conductivity being only 96 per cent. of pure copper will be 96 per cent. of 1·1238, or 0·96 × 1·1238—that is, 1·0789 mho, or $\frac{1}{1·0789}$, namely, 0·9268 ohm per mile. But the wire in question is only 600 yards long, and will therefore have less than this resistance in the ratio of 600 to 1,760, so that its resistance will finally be $\frac{600 \times 0·9268}{1760}$, or 0·316 ohm.

(*c*) Having given the resistance and conductivity, to find the dimensions.

Example.—A length of homogeneous cable strand conductor, 0·133in. in diameter, is known to be of 97 per cent. conductivity compared with pure copper, and has a resistance at the standard temperature (75° F.) of 37·5 ohms. What is the length of the conductor?

The area of this wire is approximately 0·133 × 0·133 × 0·7854, or 0·013893 square inch. Its weight per knot is therefore 0·013893 × 18,100, or 251·5lb. The resistance of a wire of pure copper one knot in length and of this weight would be $\frac{1196·7}{251·5}$, or 4,759 ohms at the standard temperature. Its conductivity would therefore be $\frac{1}{4·759}$, or 0·21013 mho. The wire in question, however, having 97 per cent. of this conductivity, would have only 0·21013 × $\frac{97}{100}$, or 0·20382, and therefore a resistance of $\frac{1}{0·20382}$, or 3·988 ohms, but its total resistance being 37·5 ohms, its length must be greater than one knot in the proportion of 37·5 to 3·988, so that its length will be $\frac{37·5}{3·988}$, or 9·425 knots.

The steps in all these calculations can of course be very much abbreviated when the method is clearly understood. Thus, the example in (*b*) is capable of being worked out directly by one fraction in the following form:—

$$\frac{872 \times 100 \times 600}{0·25 \times 0·25 \times 0·7854 \times 20000 \times 96 \times 1760}$$

that is, 0·316.

(To be continued.)

THE SCHANSCHIEFF BATTERY.

We have recently had an opportunity of examining the Schanschieff battery at 65, Basinghall-street, the offices of the Schanschieff Battery Syndicate, where a small installation is at work. There is, of course, nothing especially novel in the use of a zinc carbon couple with sulphate of mercury. Marie Davy did it long ago. The sulphate solution has, however, up to now been a very weak one—somewhere about 1 in 2,000 of water. M. Schanschieff's success has resulted from his discovery of a method by which a much stronger solution is obtained. This is almost the only novelty about the cell, but it is an important one, for it gives us a single-fluid battery which has low internal resistance, tolerably high E.M.F. (1·39 volt), freedom from smell of any kind, combined with an almost perfect freedom from polarisation. The mechanical details appear to have been carefully worked out, especially in the miners' lamps, of which several patterns were shown. Sir William Thomson has reported very favourably on a cell which he has tested, and considers it "remarkably perfect, and certainly better than any other single-fluid battery yet invented."

Mr. Preece has also tested a miner's lamp, and reports equally favourably. In a very careful test he has obtained a 1 candle-power light for eight hours at the cost for materials of one penny. There is said to be no appreciable local action when the cell is in use, and the plates are withdrawn from the solution when not in use.

The solution is supplied ready made at 4s. per gallon. By the action of the cell the mercury sulphate is nearly all reduced to metallic mercury, for which, with the partially exhausted liquid, 3s. 7d. per gallon is allowed, thus making the price 5d. per gallon, without carriage, and one fluid ounce of liquid per cell gives one ampere-hour, or 160 ampere-hours for 5d. At 1·2 terminal E.M.F. this is equivalent to 192 watt-hours, which with the cost of zinc gives about 1d. per hour for a 10 candle-power lamp.

We also saw various other forms of the battery for one or two 5 candle-power lamps, and a six-cell battery fitted into the top of an ordinary London and South Western Railway carriage lamp to give a 5 candle-power light for 10 hours. There were also some large boxes which had been made for a torpedo boat, which were 19in. by 9in. by 24in. high, each containing four cells, and giving 0·2 horse-power per box for 10 hours. Altogether we were favourably impressed with the battery, and should imagine there would be a large field for it for small work, say up to three 5 candle-power lamps for domestic use and for mining purposes.

ON THE APPLICATION OF THE DECI-AMPERE OR THE CENTI-AMPERE BALANCE TO THE DETERMINATION OF THE ELECTROMOTIVE FORCES OF VOLTAIC CELLS.*

BY SIR WILLIAM THOMSON, F.R.S.

The method described in this paper for the determination, in absolute measure, of the electromotive forces of voltaic cells, consists in the use of one of my standard ampere balances instead of the tangent galvanometer in the method given in the following statement,† which I quote from Kohlrausch's "Physical Measurements," pp. 223, 224, 230:—"The only methods applicable to inconstant elements, of which the electromotive force varies with the current strength, is to bring the current to zero by opposing an equal electromotive force. Poggendorff's method, which is very convenient, as it involves no measurement of internal resistance, requires the use of a galvanoscope, G, a galvanometer, T, and a rheostat, R, and, in addition, that of an auxiliary battery, S, of constant electromotive force, greater than either of those which are to be compared. The arrangement of the experiment is shown in Fig. 1. In the left division of the circuit are the galvanoscope G, and the electromotive force E to be measured; in the right, the auxiliary battery S, and the galvanometer T. E and S are so placed that their similar poles are turned towards each

* Communicated by the author, being a Paper read at the Manchester Meeting of the British Association, with additions. [The paper in its original form appeared in our issue of September 16th.]

† Kohlrausch was, I believe, the first to show that Poggendorff's method, when a standard galvanometer is available for measurement of currents in absolute measure, can be applied to the determination of the *electromotive force of a cell in absolute measure.* Poggendorff's method, as generally given, is merely for the comparison of the electromotive forces of two cells.

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other. In the middle part of the circuit, which is common to both batteries, is the rheostat R.

"As much rheostat resistance, W, must now be intercalated as will cause the current in E G to vanish, and the current strength J in T must then be observed. . . If J = current strength in T, the electromotive force of the battery E is E = WJ."

The deci-ampere balance, or, when a sufficient number of battery cells is available, the centi-ampere balance answers well for the current measurements here required. An arrange-

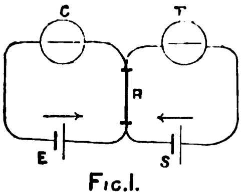

Fig. 1.

ment of the circuit which is convenient for most purposes is shown in the diagram (Fig. 2); but it may be remarked that the reversing-keys there shown may be replaced by ordinary make-break keys. Referring to the diagram, a battery of a sufficient number of cells is joined in circuit through a reversing-key with a rheostat, a deci-ampere balance, and a standard resistance. The poles of the cell to be tested are connected in circuit with a key and a sensitive mirror-galvanometer to the two ends of the standard resistance in such a way that both the battery and the cell to be tested tend to send a current in the same direction through that resistance. Care should be taken that the circuit of the cell to be tested is well insulated, and that both it and the standard resistance are free from other electromotive force. When, as in the case of Clark standard cells, the cell is incapable of maintaining a current, a high resistance galvanometer or an additional resistance should be included in its circuit. If very great sensibility is not required, a quadrant electrometer may in such cases be substituted for the galvanometer. The standard resistance must be of such a form that no sensible error is introduced

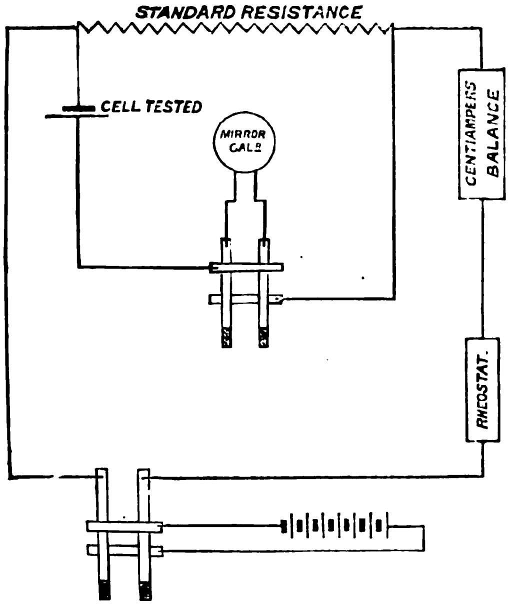

Fig. 2.

through heating by the passage of the current. A good plan is to wind well-insulated platinoid wire in one layer on the outside of a brass or copper cylindrical vessel which can be filled with water. The temperature of the water, when it is nearly the same as that of the air outside, will be very approximately the temperature of the coil. For still greater accuracy the cylinder may be fitted with a jacket and immersed in a vessel of water, and appliances introduced for changing the water in each part and keeping account of its temperature. For use with the deci-ampere balance, a platinoid resistance of two ohms is sufficient for any single cell. A resistance of two ohms, made of insulated platinoid wire one millimetre in diameter, and wound on a brass tube capable of holding half a litre of water and simply exposed to the air outside, will carry a current of one ampere for an hour without changing its resistance more than a tenth per cent. The water should be stirred when the readings are taken, and, if necessary, the change of resistance can be approximately allowed for by taking its temperature. To measure by means of the deci-ampere balance an electromotive force of from one to two volts, a battery of two small secondary cells or four Daniell cells, a resistance of two ohms such as has just been described, with the other appliances as indicated in the figure, are all that is necessary.

The method has been applied in my laboratory by Mr. Thomas Gray for the measurement of the electromotive forces of standard and other cells, and has been found very convenient. The results obtained for four Clark standard cells set up by Mr. J. T. Bottomley in March last were almost identical with one another, and gave 1·439 Rayleigh, or 1·442 legal, volts at 11deg. C. The variation of the electromotive force of these cells with temperature has not yet been determined; but assuming the average value obtained for this variation by Lord Rayleigh, namely, a fall of ·077 per cent. per degree centigrade rise of temperature, and correcting to 15deg. C., we obtain slightly under 1·436 Rayleigh volts at that temperature. This result is interesting as showing a difference of less than $\frac{1}{15}$ per cent. from that obtained by Lord Rayleigh for similar cells, which was 1·435 at 15deg. C.

MEETINGS OF SCIENTIFIC SOCIETIES.

(Week ending Thursday, 22nd December.)

TO-DAY, Friday, December 16th.

Institution of Civil Engineers.

7:30 p.m. Students' Meeting.

MONDAY, December 19th.

Inventors' Institute.

8 p.m. Ordinary Meeting. Various Papers on "Inventions Suitable for the Household." Mr. H. H. Collins, F.R.I.B.A., &c., will preside.

Society of Arts.

8 p.m. Cantor Lecture.—Series I. "The Elements of Architectural Design." By Mr. H. H. Statham. Fourth part.

TUESDAY, December 20th.

Institution of Civil Engineers.

8 p.m. Further Discussion of Dr. Edward Hopkinson's Paper on Electrical Tramways.

WEDNESDAY, December 21st.

Royal Meteorological Society.

7 p.m. Papers to be read:—

"Mean Temperature of the Air at Greenwich from September, 1811, to June, 1856." By H. S. Eaton, M.A., F.R.Met.Soc.

"Report on the Phenological Observations for 1887." By the Rev. T. A. Preston, M.A., F.R.Met.Soc.

"Earth Tremors and the Wind." By Prof. John Milne, F.R.S., F.G.S.

"Pressure and Temperature in Cyclones and Anti-cyclones." By Prof. H. Allen Hazen.

THURSDAY, December 22nd.

Society of Telegraph-Engineers and Electricians.

8 p.m. Further Discussion on Mr. A. Cockburn's Paper on "Safety Fuses for Electric Lighting."

Royal Society.

4:30 p.m. Ordinary Meeting.

*** Particulars of meetings to be held or papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

With the *conversazione* given by Sir CHARLES and Lady BRIGHT, at the Institute of Painters in Oil Colours last night, an eventful and anxious year for the SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS was brought to a brilliant and satisfactory termination. It would be idle to disguise the fact that in the autumn of 1886 widespread misgivings were felt at the prospects of the coming year, and those misgivings found a definite expression in the pages of this journal. The Society had several matters in hand of considerable importance to the scientific and commercial interests associated with its public reputation and influence. Besides this there was the Telegraph Jubilee to be celebrated in a manner worthy of the occasion and the country. Never in the career of the Society had there been a time when so much depended upon the vigour, dignity and tact of its President; and never, as it seemed to many of its leading members, had the risk of failure seemed so imminent. As we were foremost in giving expression to these apprehensions, we are now desirous of being equally prompt to acknowledge that they have been falsified by the event. The Society, if it has not gained in strength, is not seriously weakened; the attendance has been up to the average, and the papers discussed have maintained their customary excellence. As to the Jubilee banquet, its organisation and management reflected the highest credit upon everybody concerned, and it certainly took a distinguished position among the festivities of the year. In short, although the President's health, which was the chief cause of anxiety, has unfortunately prevented him from taking so prominent a part as his eminence entitled him to in these matters, the Council have supplied all deficiencies, so that the credit of the Society has sustained no injury.

In the president-elect for the ensuing year the Society will have the advantage of possessing a man who already enjoys popularity among its members, and whose sober judgment and business capacity promise well for its management. There are several questions of importance still to be settled relating to the work of the Society and its future sphere of action, all of which will tax its administration to the utmost. Among the former we may mention the proposed increase in the frequency of its meetings, an alteration which will certainly be needed if the contemplated change of its title be carried out. Of the Society's committees on the Electrical Standard Laboratory and the Fire

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Office Rules, mentioned in the annual report, we expressed our opinion at the time they were proposed. In its original conception the former was open to the objection common to all proposals for subsidising science from public funds. This may not be the shape the idea has finally taken; but the committee's report will be waited with some curiosity. We have stated in a note what precisely are our views on the Fire Office Rules; and need only add here that nobody will be more gratified than ourselves if the Society succeeds in stamping with its high authority rules which shall command the adhesion of all the Insurance Offices. It is fitting and desirable that such rules should emanate from a competent and recognised body of electrical experts. The danger is that such a body may forget that it cannot impose its dicta either on the offices or the public. On the other hand, the Insurance Offices have much to gain by accepting authoritative guidance; and if they decline to do so on insufficient grounds they will incur a grave responsibility.

With regard to the proposed alteration in the title of the Society, a matter of such serious import cannot be fully discussed in the present article. There is no mistaking, however, the meaning of the change; and we suppose we must take some of the credit—or the blame, whichever suits our critics best—for bringing it about. Before the Society changed its title, or rather enlarged it, once before, we had strongly advised the adoption of a single comprehensive designation which would cover the ground then vacant. Since that time the field of electrical science and industry has widened considerably, and no choice could be better than the one to be submitted for the approval of the Society's members early next year. That this journal has had something to do with the particular title recommended will be pretty generally understood; and to some people it may look like taking the wind out of our sails. It would be nearer the truth to say that we have supplied the wind at whose bidding the sails of the Society have been set. But that is a small matter. It will rest with the members of the electrical engineering profession on the one hand to decide whether the Society under a new title, and with wider aims, is likely to satisfy their wants; and on the other, whether the society will be able to submit a programme, as well as a title, that may reasonably fulfil these requirements.

There is another body of men, however, to be consulted, namely, the Telegraph-Engineers, and to these the proposed change in the title of a Society hitherto peculiarly identified with their profession may not be wholly agreeable. But seeing that the Society gained strength when it included electricians other than those connected with the telegraph, the probability is that it would be still further re-enforced by embracing all the electrical professions. "The Institution of Electrical Engineers" would almost certainly do this, and with gratifying results to the Society and everybody belonging to it. Latterly a large number of young electrical students have been attracted to The Society of Telegraph-Engineers and Electricians for lack of a better. On these young men the Society will largely depend in the future for recruiting its members, and the surest way of attaching them permanently to it will be to reconstruct the Society on a basis more conformable to the profession to which the majority of the students will eventually devote themselves.

It will be seen from this that we heartily approve of the projected Institution of Electrical Engineers, and that in advocating as we have done a trade association of that name there is no desire to see the old society play the part of Mr. Macquoid's discarded grey mare, whose pathetic gaze after her master's new mount attracted such notice on the walls of the West Gallery last night. We have not suggested any "New Love" in the place of the old, but merely the addition of a serviceable nag on which a man of business may ride to market. As we have already observed, it remains with electrical engineers who strongly desire a business association complementary to the existing societies whether they will, in the changed circumstances, push forward their own scheme. Much may depend upon what the Society of Telegraph-Engineers intend to do, and how soon they do it; but in the long run, it seems to us, a business or trade association with a wider scope than the one now being advanced will be necessary, and will be the more easily constructed on the Society's new and broader foundations. The Association scheme has taken a narrower basis than, for our own part, we have thought desirable. Something may now be learnt from the action of the parent Society. When the time comes for seriously discussing these several questions we shall lend our voice, as heretofore, for upholding every useful institution; but we shall not be deterred from advocating the formation of new ones by the jealousy of our enemies or the timidity of our friends. There was another picture that attracted some attention at the *conversazione* last evening. It was Mr. Wardle's little dog frightened by a flock of hissing geese. The geese have quite a brave air; but then the dog is only a very young puppy.

THE PATTEN DOUBLE-ROTATION DYNAMO.

The fact that the output of a dynamo machine for a given weight of material increases rapidly with the speed at which the armature is driven has frequently led to the suggestion that the field should be rotated at the same time in the opposite direction to the armature, but the mechanical difficulties of this construction have hitherto stood in the way of its satisfactory realisation. Lieut. F. J. Patten (of the U.S. Army) has recently designed a machine of this description, of which the following description is given by the New York *Electrical World*:—

A firm and rigid structure having but a single spindle or axis and only two bearings, the least that any machine can have, and giving a continuous unbroken circuit through both armature and field while in motion, are the essential conditions to be met in order that such a system of construction shall give the double output clearly indicated by the theory of the problem.

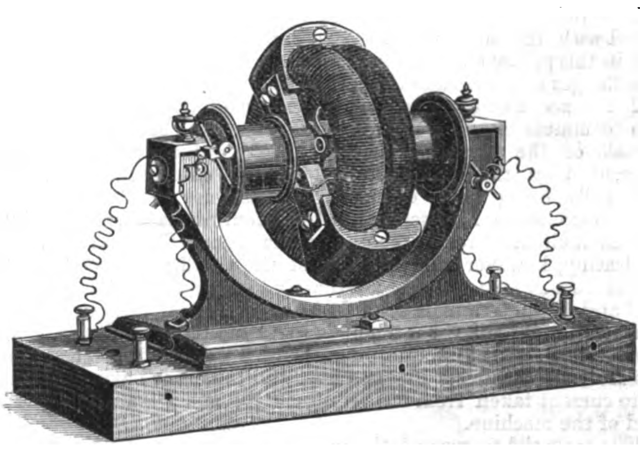

Fig. 1.

The engraving, Fig. 1, shows a perspective view of one form of generator constructed upon this system, and Fig. 2 represents a vertical section through the axis of the machine, from which the arrangements of the parts will be readily understood. F F is a rigid frame or support of cast-iron resting upon a base plate, B B.

Driven through and secured immovably in the upper extremities of the frame is a heavy steel spindle, X X, which constitutes the single axis of the machine and upon which are suspended the revolving parts, both of which turn freely upon the same fixed spindle. Q Q is a heavy pulley provided with internal boxes, to the inner end of

which is secured an arbor, M M. This arbor carries the circular field-magnets F M, having projecting field poles, N and S. An exactly similar pulley, P P, at the opposite extremity of the spindle is provided with a similar arbor, A A, which carries the armature of the machine. Thus the two revolving parts are suspended freely upon a single spindle or axis, which is held rigidly in the supporting frame.

Evidently the brushes in any machine designed for the generation of direct currents must maintain a fixed relation to the poles of the field or the neutral line. To secure this with a revolving field, a movable collar, *c c*, is carried upon the inner extremity of the pulley Q Q, to which the field is secured, and this collar is provided with arms that carry the brushes *b* and *b*, which, turning with the field, maintain constantly their proper relation thereto. In a similar manner the commutator C C is fixed upon a projecting cylinder that forms the inner end of the pulley to which the armature is secured. Arranged thus, the position of the brushes upon the commutator is evidently independent of the relative speed of the two parts of the machine, and the brushes remain at the non-sparking point whether the speeds of the armature and field are alike or different. For continuous currents a single circuit traverses the entire machine while in motion precisely the same as were the field at rest.

The current generated in the armature is taken from the brushes in the usual way, and either direct or as a shunt traverses the coils of the field. The terminals of the coils are then led through the two passages in the pulley Q Q, and are attached to the two insulated rings secured to the outer face of this pulley concentrically and insulated therefrom. These rings constitute the terminals of the internal circuit from which the brush contacts T + and T –, supported upon the frame F, transmit the continuous current to the external circuit.

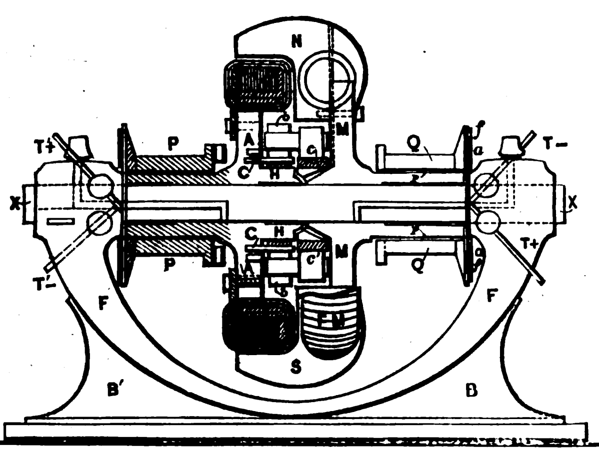

Fig. 2.

The pulley P P, which carries the armature, is similarly provided with insulated rings, *f′ a′*, secured to its outer face. There are in this pulley similar connecting channels through which these two flanges may be made the terminals of the armature coils direct, either in series or otherwise, and the brushes being removed from the commutator, the terminals T′ + and T′ – become the terminals of the armature circuit, through which an alternating current may then be delivered to the external circuit. All the coils being thus connected it becomes evidently necessary to excite the field separately by a continuous current led into the field circuit through the opposite terminals T + and T –. As indicating, however, the flexibility of the machine the coils of the armature may be connected alternately to the commutator segments C C and to the terminals on P P in pairs successively around the armature. Where the machine is so connected it will supply current to two distinct circuits, one having a continuous current and fed from the terminals T + and T –, and the other having an alternate current taken from the terminals T′ + and T′ – at the opposite end of the machine.

The essential feature of the machine or system of construction lies, however, in its evident possibility of developing a high armature velocity with a comparatively low speed. This statement, though apparently paradoxical, is nevertheless true, for both parts may be driven at a speed far within the usual limits of practice, say 300 or 400 revolutions per minute; and the resultant speed of armature through field with this rate of motion, which determines the output of the machine, or its capacity for transforming mechanical into electrical energy, will correspond under the given conditions to an armature speed of 600 or 800 revolutions per minute, as the case may be. The system is, however, capable of the highest possible speeds attainable, as will be evident from an inspection of the mechanical arrangement of the different parts.

The frame F holds the spindle X X rigidly fixed, and both parts in revolving might tend to set up vibrations in the machine and tend to shake the structure; but, owing to the opposite revolution of the parts, the action produced by one revolving part is counteracted and neutralised wholly or in part by that of the other, and as the resultant action is that due only to the preponderance of the effect of one over that of the other, they produce but little resultant effect, and the machine can be driven at a high speed without perceptible jar to the machine or the surrounding structure.

To effect the double revolution of the two parts in opposite directions it is only necessary to twist one of the driving belts from the countershaft; but, if preferred, it is a simple matter to drive both the pulleys in opposite directions with a single belt and a single countershaft.

To accomplish this an overhead shaft is placed at right angles to the spindle X X of the machine, and is provided with a fixed and a loose pulley, the diameter of the countershaft pulleys being equal to the horizontal distance from the middle of one pulley of the machine to the middle of the other. A single belt passed over the countershaft pulley and under each pulley of the machine will then drive the latter in opposite directions with a quarter turn only on each side.

The system is applicable to any armature and to any field-magnet the form of which is susceptible of revolution upon a central axis, and the brushes and commutators may be arranged outside as well as inside. The machine and adjusting parts operated by means of a shunt circuit may be secured to the arbor and arranged to control the position of the brushes so as to maintain their contacts at the proper diameter of commutation while the machine is in motion. Evidently, for all forms of alternate current machines (the multiple fields of which are usually arranged in a circular form and are well adapted to revolution) the commutator is absent, and hence are removed all difficulties from the problem, and the highest desirable number of alternations of current are obtainable either with fewer fields than before or at half speed with the same number of fields as before.

Viewed as a system of construction for either continuous or alternating current generators, the machine is designed as one of double capacity for a given weight of wire and iron; and, according to the inventor, a given installation to transform into electrical energy a stated amount of horse-power would, with the system described, require only one-half the plant in wire and iron employed at present.

The life of the plant, Lieut. Patten holds, would be equally increased, resulting from the fact that the actual speeds may be so low, and react against each other in such a way as to make a noticeable difference in the account for depreciation.

REVIEWS.

The World's Workers: Thomas A. Edison and Samuel F. B. Morse. By Van Buren Denslow, LL.D., and Jane Marsh Parker. (London: Cassell and Co.)

If a good deal of undeserved prejudice exists in this country against American notabilities the blame may be fairly laid to the biographies supplied to us from their native land, a typical specimen of which has been reproduced by Messrs. Cassell for English readers. Except that a great part of the Edison memoir is taken up with extracts from a very indifferent book on electrical science lately published by the same firm, we should be at a loss to conjecture what claims such a book has to the attention of any sane person, publisher or reader. For turgid gush and pretentious twaddle we have hardly seen any biographical sketch to equal this. If the stories here told of Edison were true, and the words quoted as his were authentic, we could only say that his detractors have never intentionally belittled him as his biographers unconsciously have done. But we do not believe half the stories, and very little of the alleged Edisonian science. There is one, and only one, good thing in the book, and English readers will detect its significance. Edison's sister is in the habit of relating, for the delectation of Edison's worshippers, that her brother, at the age of six, on being told that some newly-hatched chicks were due to the warmth of a sitting hen, suddenly disappeared. "Would you believe it if I told you he was found in the stable coiled up on a batch of turkey eggs trying to hatch them?" No, Miss Edison, we would not, and we know that you do not expect us to. Edison's biographers dimly see that this Miss Edison is a smart sort of girl. And so do we—not at all dimly; so smart, indeed, that we refuse to credit any brother of hers with being the fantastic

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and foolish person this book would make him out to be. The Morse memoir is in a little better style, but possesses no feature of novelty or interest to justify its appearance in this form.

Fortschritte der Elektrotechnik. By Dr. M. Kiliani, Dr. E. Pirani, and Dr. Karl Strecker. (Berlin: Julius Springer, 3, Monbijouplatz.)

Current electrical literature is already so large that Dr. Strecker's volume of abstracts, of which the first double part has just reached us, should prove of great value both to the student and the practical man. Its aim is to be a catalogue *raisonné* of all electrical matter which has appeared during the first half of 1887 in the principal technical journals and patent lists of the world.

The arrangement of the subject matter is extremely good and convenient for rapid reference. The whole book is divided into 19 sections, *e. g.*, "Dynamos," "Arc Lamps," "Transmission of Power," "Telephones," "Electro-Chemistry," &c. Any three or four references to each will give some idea both of the labour it has cost the authors and, on the other hand, of the labour it should save the users by enabling them to find in a moment where information on any electrical subject during the first half of the year is to be had. We may mention that considerably more than half the references are to English and American journals, and that in those cases the headings are in English; the book will therefore be of considerable service, even to those of our readers who have not mastered what Mark Twain calls "The awful German language."

The Telephone Companies of the United Kingdom. By C. L. W. FitzGerald. (London: Effingham Wilson and Co.)

This pamphlet consists chiefly of a number of articles reprinted from the *Weekly Bulletin* on the progress and financial condition of the telephone companies now in operation throughout the United Kingdom. The moral of the story appears to be that the Postmaster-General ought to make haste and buy up all the plant and goodwill of his aggressive competitors. It is to be hoped that investors will not be tempted by this very problematical and remote contingency. Mr. FitzGerald's compilation, however, will be found useful for reference in regard to the affairs of the various telephone companies.

ELECTROLYSIS OF IRON SALTS.

BY ALEXANDER WATT.

(Continued from page 52.)

Protonitrate of Iron.—A solution of this salt yielded a black deposit of iron in a state of fine division, interspersed with glistening particles of the metal palpable to the touch. A quantity of nitrate of potash was next added to the solution, when at first there was a slight disposition for the metal to go down in the reguline form, but after a few seconds' immersion the plate again blackened, and in less than a minute it became thickly coated with a gelatinous film, covered with hydrogen bubbles of about the size of mustard seed, which remained on the plate for at least half an hour, being coated with a thin rusty film. On leaving a fresh plate in the solution for about an hour, nearly the whole of the iron was thrown down in the form of a black or greenish-black gelatinous mass, which oxidised with great rapidity. A solution of the protonitrate was next made by the battery method, by passing a current from five small Daniell cells through a sheet-iron anode, suspended in a very dilute solution of nitric acid, the circuit being completed by a carbon cathode. The liquid being a good conductor, the electrolytic action was very energetic, and the iron anode became rapidly dissolved, and in less than half-an-hour metallic iron, in the form of granules, was deposited upon the carbon. A copper plate was now substituted for the carbon, which at first received a dark grey metallic film, but in the course of a few moments the deposit assumed the form of a black gelatinous mass, which subsequently oxidised, forming a bright orange-yellow powder.

Double Sulphate of Iron and Potash.—A bath was prepared from a mixed solution of the respective salts, the iron salt being in excess. With three cells of the small Daniell battery, arranged in series, a fine white and very bright deposit was obtained upon a copper plate immediately after immersion, and the deposition proceeded very uniformly for half-an-hour, when the deposit became somewhat streaky; this was remedied, however, by adding more sulphate of potash. Deposition took place very freely, and the anode was considerably dissolved in the course of an hour. This is undoubtedly a very good electrolyte for the deposition of iron, and does not appear, if faintly acid, to oxidise so freely as the ammonio sulphate solution.

Further Experiments with Persalts of Iron.—In my first paper I gave the results of some experiments with solutions of perchloride and persulphate of iron, in which I was unsuccessful in obtaining deposits of metallic iron. Having recently electrolysed some other persalts of this metal with somewhat more favourable results, I determined to renew my experiments with the perchloride and persulphate with a view to ascertain if it would be *possible*, under other conditions than those which governed my former trials, to deposit metallic iron from solutions of these salts. In treating the pernitrate as explained in the last paper I succeeded in obtaining copious deposits of metallic iron in a highly comminuted condition, thereby proving that the electro deposition of iron from a persalt (albeit not in a reguline form) is possible. Gore, in his "Art of Electro-Metallurgy," page 245, states that "solutions of persalts of iron yield no metallic deposit, but are reduced to protosalts by the passage of an electric current." That this statement is not correct I will now endeavour to prove. In the first place, a moderately strong solution of pernitrate of iron yields freely a black deposit of metallic iron, which may be collected, as I have shown, and possibly employed in pharmacy. Further, I obtained a reguline metallic coating of iron upon a strip of sheet copper from a solution of the peroxalate of iron. This latter result led me to believe that if the proper condition of the electrolyte could be obtained it was probable that solutions of all persalts of iron would yield metallic deposits. To determine this I prepared a sample of perfectly pure hydrate of the sesquioxide of iron, which was carefully washed and employed in a moist state. With this I formed saturated solutions of perchloride and persulphate respectively. I then determined to try if I could obtain a metallic film upon a copper cathode from a very weak solution of the perchloride (1 drachm of concentrated solution to 3oz. of water) with the current from five small Daniell cells in series, and was pleased to find that under these conditions a film of metallic iron began to form immediately, and in a few moments the plate was covered with a fairly bright deposit of the metal; after awhile, however, the film became blackish at the lower corners. A solution of the persulphate of iron in about the same proportions was next tried with three cells, when a bright deposit of iron at once took place at the corners and lower edges of the plate, which gradually extended upwards in the form of a horseshoe, which character it maintained until the plate was withdrawn. I have frequently noticed that some weak solutions of iron—especially *very* dilute solutions—yield deposits of this form, the metal positively refusing to coat the upper portion of the immersed surface; on the other hand, instances frequently occur, not with iron alone, but with some other metallic solutions, in which the film, while absolutely refusing to form upon the lower surface of the cathode, appeared only on the surface nearest the top of the liquid. Being thus far successful with the perchloride and persulphate solutions, I next tried a very weak solution of the pernitrate. In this trial I was less successful, but when the cathode was briskly agitated in the bath a greenish, non-adherent film was obtained, which, when dried and removed from the plate, was attracted by the magnet. It was metallic iron, therefore, but only in a semi-metallic state until dried. Having thus proved that iron *can* be deposited from solutions of its persalts when the proper conditions have been arrived at, I will now proceed to describe some further experiments which have recently engaged my attention.

Peroxalate of Iron.—A solution of this salt was prepared by dissolving freshly precipitated hydrated sesquioxide of iron in

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a hot and strong solution of oxalic acid. The hydrate entered into solution very freely, forming a greenish-yellow liquid. The current from five small Daniells was used, with an iron anode and copper receiving plate as before. Shortly after immersion the cathode became coated with a metallic film of a grey colour. After a few minutes' immersion a grey non-metallic pulverulent deposit rested upon the plate, which was easily brushed off, while a similar powdery film, but of a yellow colour, appeared on the immersed portion of the anode. In a short time the liquid became turbid, and a yellowish deposit was subsequently found at the bottom of the vessel.

Sesquicitrate of Iron.—A bath was prepared from this salt by digesting freshly precipitated and moist hydrated sesquioxide of iron in a hot and nearly saturated solution of citric acid; when cold the solution was diluted with about twice its bulk of water. Five Daniells were employed, when a strip of sheet copper received a deposit of iron soon after immersion. The film, however, was neither so bright nor of so good a colour as that obtained from the protosalt.

Sesquiacetate of Iron and Acetate of Soda.—A solution of the sesquiacetate was first formed by dissolving hydrated peroxide of iron in acetic acid with the aid of moderate heat. The solution was next moderately diluted (with about two parts of water), and acetate of soda crystals then added and dissolved in the liquid. With the current from five Daniells, a metallic deposit of iron was at once obtained upon a copper plate, this electrode being allowed to remain stationary in the fluid. In about a quarter of an hour the film—which retained its metallic character—assumed a greyish colour, and became blistered all over, showing that the deposit, though reguline, was non-adherent.

Benzoate of Sesquioxide of Iron.—A solution was prepared by dissolving freshly precipitated hydrate of peroxide of iron in a hot solution of benzoic acid; this acid, being very sparingly soluble, even in hot water, yielded but a very weak solution, so it was resolved to use it while still warm. The solution was a very bad conductor, and no deposit could be obtained with five Daniells, while the cathode was stationary. When this electrode was briskly agitated in the solution a slight metallic film appeared, on the upper part of the plate only. There was a moderate evolution of gas.

Benzoate of Protoxide of Iron.—A solution was formed by dissolving recently prepared carbonate of iron in a hot solution of benzoic acid. As in the previous case the solution was a poor conductor, and yielded its metal only when the cathode—a strip of sheet copper—was briskly moved about in the bath. The same number of cells were used as in the former experiment, and the solution employed hot, but only a trifling film of iron appeared upon the upper portion of the receiving plate.

Ammonio Nitrate of Iron.—This bath was prepared by dissolving iron in cold dilute nitric acid by the action of the current, the operation being kept up until the solution was as neutral as possible, when a little ammonia was added. As is the case with most other nitrates, the solution had little disposition to yield a reguline deposit of metal. A slight metallic film appeared upon the cathode for an instant, but this quickly changed into a black deposit of pulverulent iron precisely similar in character to that obtained from the persalt. This black film, which soon became very thick upon the plate, was slimy to the touch, and consisted of metallic iron in a highly comminuted state, interspersed with bubbles of hydrogen, some of which were of considerable size, and retained their position upon the plate for many seconds—probably half a minute. The black deposit was washed off the plate into a glass containing hot water, and a fresh plate immersed in the liquid, and allowed to remain stationary for about two minutes, by which time it received a copious deposit of the same character as before, which was afterwards removed by washing, as in the previous case. Several plates were coated with the black deposit in this way, and the finely-divided metal afterwards well washed, drained upon a filter, and dried. The black powder thus obtained was then placed upon a sheet of paper, and treated with the magnet in the following way:—A piece of thin paper was laid over the poles of a small horseshoe magnet—to prevent the finely-divided metal from attaching to the magnet itself—which was then drawn across the metallic particles, but at a short distance from them, when they rapidly ascended and clung to the paper, and to each other, forming a metallic fringe of about a quarter of an inch in depth and about an inch in length. The fine metal, thus suspended, was then conveyed to a second piece of paper, and the magnet withdrawn, when, of course, the metallic particles became dislodged and fell upon the paper. The remaining atoms of metal were collected and transferred in the same way, when it was found that the first piece of paper upon which the fine metal had been placed was perfectly free from particles of any kind, showing that the black deposit obtained from the solution in question consisted solely of metallic iron. It should be mentioned that when these black deposits of iron, after being drained from surrounding water, are dried slowly, a film of oxide forms upon the surface of the particles, giving the dried material a reddish tint. This does not, however, prevent the magnet from attracting them. In this experiment the anode, which was much worn, remained exceedingly bright.

(To be continued.)

ON SOME INSTRUMENTS FOR THE MEASUREMENT OF ELECTROMOTIVE FORCE AND ELECTRICAL POWER.*

By J. A. Fleming, M.A., D.Sc., and C. H. Gimingham.

(Concluded from page 111.)

Let us examine the theory of the instrument a little more closely. Let R (Figs. 4 and 5) represent the resistance of the thick wire or current coils, and let r represent the resistance of the fine wire or volt coils, and let ρ stand for the resistance of the lamp or other circuit in which the dissipation of energy is being measured. Given the ends of these thick and thin wire coils, we may then join them up to the lamp in either of two ways, as shown.

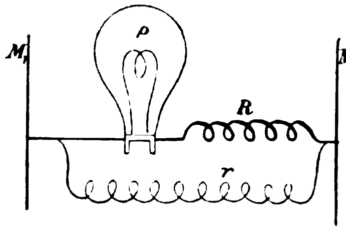

Fig. 5.

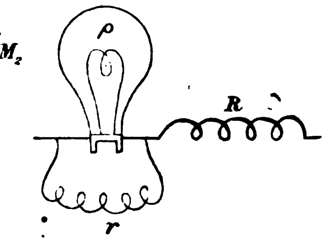

Fig. 4.

What we actually do in the use of a thick and thin wire electro-dynamometer, employed as a wattmeter, is to measure the product of the strengths of the currents in the thick and thin wire coils respectively, by measuring the electro-dynamic attraction between these circuits when held in certain fixed positions. If, however, the circuits are joined up to a lamp, although the current in R is equal to the current through the lamp, yet the current through r is not proportional to the difference of potentials on either side of the lamp, but greater by an amount which depends on the ratio of ρ to R. If W represents the true watts taken up in the lamp under measurement, and W_1 represents the observed watts by the dynamometer, on the assumption that it has been calibrated for one particular lamp of very high resistance compared with R, then

$$W_1 = W \frac{\rho + R}{\rho} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

for W_1 is made up of two factors—one a number proportional to the current in R, which is the current through the lamp, and another factor which is proportional to the difference of potentials over all between the outside terminals of lamp and resistance R.

This last is greater than the potential difference on either side of the lamp, in the ratio of $R + \rho$ to ρ.

* A paper read before the Society of Telegraph-Engineers and Electricians, November 25th, 1887.

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Next let the fine wire coils be joined to the terminals of the lamp. The current in r is now proportional to the potential difference on either side of the lamp. The current in the thick wire coils is not, however, identical with that through the lamp, but equal to that through the lamp and fine wire coils together. If c stand for the current through the lamp, and C for the current in the thick wire coil R, then

$$c = \frac{r}{r+\rho} C,$$

and accordingly, if, as above, W stand for the true watts expended in the lamp, and W_2 for the watts as observed on the dynamometer, we have the relation

$$W_2 = W \frac{r+\rho}{r} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

From equations (1) and (2) we have

$$W_1 \rho = W \rho + W R,$$
$$W_2 r = W r + W \rho ;$$

hence,
$$W^2 \frac{R}{r} = (W_2 - W)(W_1 - W) ;$$

or,
$$W^2 - \left(\frac{r}{r+R}\right)(W_2 + W_1) W + \left(\frac{r}{r+R}\right) W_1 W_2 = 0.$$

The solution of this quadratic equation gives W.

It is not difficult to show that this quadratic equation always has one real positive root, since r is greater than R, and W_1 and W_2 are positive quantities. We arrive, therefore, at this result:—If any given wattmeter of this type has been calibrated on a lamp or other circuit of which the resistance is very great compared with the thick wire or current coils, supposing the connections made as in Fig. 4, then the observed readings of the wattmeter, when used with any other lamp or circuit, will not give the true watts expended in that circuit, but give a value which is rather too high, and of which the error will depend on the value of the three resistances, R, r, and ρ. We can, however, eliminate the error, and obtain a number proportional to the true rate of expenditure of energy in the circuit ρ, by taking two observations with the high resistance coils joined up respectively, as in Figs. 4 and 5. If these readings are called W_1 and W_2, the insertion of these in the quadratic equation above will enable us to find a value (W) which is proportional to the real watts, and that without knowing the resistance of the lamp being tested.

In the construction of a wattmeter of this type it is evidently important that the current coils should have as low a resistance as it is possible to secure in comparison with that of the movable or voltmeter part. In our wattmeter the fine wire coils are of German silver wire, and have a resistance of 1,000 to 1,200 ohms. The thick wire or current coils are of the highest conductivity copper, and in the instrument designed as a lamp wattmeter, to read direct from 1 to 400 watts, have a resistance of about ·1 or ·2 ohm. It is intended to issue wattmeters of three grades—one reading from 1 to 400, the next from 10 to 4,000, and the highest from 100 to 40,000, and suitable for electromotive forces of 50 to 250 volts.

In the wattmeter above described the scale is, of course, a scale of equal divisions. In the form of instrument adapted for lamp measurements, the circular scale is divided into 400 divisions, and each division represents 1 watt. By means of a wattmeter and voltmeter of the above description all the four electric elements of a lamp can be measured at once. Let the wattmeter be joined up, as indicated in the above diagram (Fig. 4), and let, in addition, the terminals of the voltmeter be connected to the points A and B, the voltmeter then reads the potential difference of A and B, and the wattmeter reads the consumption of power between A and B. If W be the reading of the wattmeter and V that of the voltmeter, the quotient of W by V gives the current through the lamp, and the quotient of the square of V by W gives the hot resistance of the lamp. We have designed an instrument which shall be a combination of watt and voltmeter, and enable the two measurements of potential difference at extremities of a circuit and power consumed in that circuit to be simultaneously measured, and therefore to give at once the current in the circuit and the hot resistance. In this instrument the fixed coils would be wound compound, with two coils on each, one thick overlaid by a thin wire winding.

The connections of the fine wire windings on the fixed coils are so arranged in conjunction with a switch, that when the switch is turned one way the solenoids have, as ordinarily arranged, a N pole at the centre of each, but when the switch is turned the other way this pole is abolished. Hence, if a current flows through these fine wire windings in series with the movable coils, then, according as the switch is set one way or the other, the current will operate the instrument or not, and that without changing its resistance or affecting the current in the movable coils. Let, then, the thick wire coils be traversed by a main current, and the thin wire coils by a current derived by connecting their extremities to the ends of the conductor traversed by the current through the thick wire coils. The electro-magnetic force operating to displace the movable part of the instrument will be the resultant of two forces—one due to the product of the strength of the current in the thick coil and the current in the movable coil. This product is proportional to the power consumed in the conductor. Secondly, in addition, there is a force due to the action of the current in the fixed fine wire coils on the current in the movable coils in series with them. This force is proportional to the square of the current strength or to the square of the volts at the ends of the conductor. Hence, if the switch is turned so that both thick and thin wire fixed coils are operative, the electro-magnetic force on the movable coils is proportional to the watts added to the square of the terminal volts. If W be the power consumed in the conductor, and V the potential difference at its extremities, then this reading of the instrument will be proportional to $A W + B V^2$, when A and B are instrumental constants. Next, let the switch be turned so as to render the fine wire coils electro-magnetically inoperative, although not altering the resistance of the total fine wire circuit. In this case the reading of it is simply proportional to the power consumed in the conductor, or to A W. We have therefore, by two readings, the power consumed and the terminal volts of the conductor or circuit, and hence, by simple division, the current and hot resistance.

In this method of measuring a current, the movable part of the instrument is not traversed by any but a very small current, and hence the difficulty generally experienced in getting a large current in and out of a freely-moving circuit has not to be combated. In considering these instruments as permanent standards, the question obviously arises as to the permanence and perfect elasticity of the steel spring. The steel chronometer spring is made of the very best and most carefully-tempered steel. The use in chronometers justifies the statement that, when not strained beyond the limits of elasticity and when not kept in strain for a longer time than necessary to take a reading, the elasticity is perfect. There is only one caution which should be taken in using these instruments. After taking a reading, the central index hand should be turned back to zero before putting the instrument away. If the voltmeter is closed up and put on one side, with a permanent twist upon the spring, then a slight deformation of the spring may result, which will in time disappear, but not immediately. The elastic modulus which is brought into play in the use of a spiral spring is somewhat similar to that which is operative when a beam is bent. The spiral is not drawn out, but is twisted round and bent slightly into a smaller radius. Under prolonged strain a very slight deformation occurs, which disappears gradually on the removal of the stress, and this deformation is a function both of the stress or strain and the time under which the elastic body is submitted to that stress.

On this point we may quote the experience of Prof. W. Kohlrausch, who, in a paper in the *Electrotechnische Zeitschrift* (see *Electrician*, March 25, 1887), gives the result of prolonged experiments on the employment of spiral springs in measuring instruments. The effect of age, judging by observations on a brass spring extending over a period of seven years, may be completely neglected. Continuous and prolonged deformation produces a small amount of permanent set, so that the spring, when released, does not return to its original position, but this does not actually alter the indications of the instrument

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if the readings are taken from the new zero thus formed. Steel is in this case less affected than German silver. Oft repeated but intermittent deformation, as exhibited by a spring of ninety convolutions and 2¼in. long being stretched so as to change from a length of 3in. to 9in. 200 times per minute for 400 minutes, introduced no sensible alteration into its subsequent indications.

An increase of temperature of 18deg F. raised the indications of a Siemens torsion galvanometer about one-tenth per cent., so that the reduction in elasticity of the spring is apparently almost equal to the decrease in moment in the magnet. Further experiments on loaded springs confirmed this conclusion, and showed that steel was again to be preferred to German silver. We think, therefore, that there is sufficient evidence to lead us to believe that the selection of a highly-tempered steel chronometer spring as a means of weighing the electro-dynamic attraction of coils traversed by currents will not be found to lead to appreciable errors.

Instruments with the suspension we have here designed and used are not very well suited for marine use, but we are engaged in arranging a mode of suspending the movable coil which will render the instruments independent of any levelling when in actual use.

TABLE OF CURRENT DENSITIFS

Current carrying capacity of the B.W.G. with densities of 1,000 to 5,000 amperes per square inch of cross section.

B.W.G.	1,000.	2,000.	3,000.	4,000.	5,000.
30	·1	·2	·3	·4	·5
28	·1	·2	·3	·4	·5
26	·2	·4	·6	·8	1·0
25	·3	·6	·9	1·2	1·5
24	·4	·8	1·2	1·6	2·0
23	·5	1·0	1·5	2·0	2·5
22	·6	1·2	1·8	2·4	3·0
21	·8	1·6	2·4	3·2	4·0
20	1·0	2·0	3·0	4·0	5·0
19	1·4	2·8	4·2	5·6	7·0
18	1·9	3·8	5·7	7·6	8·6
17	2·6	5·2	7·8	10·4	13·0
16	3·3	6·6	9·9	13·2	16·5
15	4·1	8·2	12·3	16·4	20·5
14	5·4	10·8	16·2	21·6	27·0
13	7·1	14·2	21·3	28·4	35·5
12	9·3	18 6	27·9	37·2	46·5
11	11·3	22·6	33·9	45 2	56·5
10	14·1	28·2	42·3	56·4	70·5
9	17·2	34·4	51·6	68·8	86·0
8	21·4	42·8	64·2	85·6	107·0
7	25·4	50·8	76·2	101·6	127·5
6	32·4	64·8	97·2	129·6	162·0
5	38·0	76·0	114·0	152·0	190 0
4	44·5	89·0	133·5	178·0	222 5
3	52·7	105·4	158·1	210·8	264·0
2	63·3	126·6	189·9	253·2	317·5
1	70·7	141·4	212·1	282·8	354·0
0	90·8	181·6	272·4	363·2	454·0
00	113·4	226 8	340·2	453·6	567 0
000	141·9	283·8	425·7	567·6	706·0
0000	161·8	323·6	485·4	647·2	808·0

THE ELECTRIC CURRENT.—AN OVERLOOKED ANALOGY.*

BY PROF. F. C. VAN DYCK.

Readers of Prof. Ayrton's admirable book, "Practical Electricity," will see on page 2 a statement of that author's views as to what the electric current is *not* like.

It appears to me worth while to say something on the other side of the question, pointing out a basis of analogy between the electric current and what may be called a sound current. What follows refers to a single experimental fact, viz., that the energy developed (as heat, for instance) in an electric circuit varies as the *square* of the current in that circuit. Or, it may be put in this form, viz., the energy expended in maintaining difference of potential varies as the square of the quantity of electricity transferred from higher to lower potential.

How does this fact accord with the various hypotheses as to the nature of current? In the first place the electric current cannot be regarded as analogous to a current of *water*, for the energy of a water current varies as the cube not the square of the current. This is so important in this connection that I venture to give a brief statement of the reason for the fact by way of reminder.

To say that the energy of a water current varies as the cube of the current, because one must maintain n-squarefold head to get n-fold flow does not *explain* the matter, but really states it from another standpoint. The real explanation is to be found in the character of the flowing substance. Water is practically incompressible—that is, its volume is independent of the pressure causing flow. Hence to get n-fold current from a given orifice or tube we must force n times as many volume-units (drops) out in a given time. Therefore each volume-unit must be made to travel n times as fast as it did when unit current flowed. Consequently, each volume-unit has n-square energy, and, as there are n times as many of them traversing the orifice or tube, the energy of the n-fold current must be n-cube-fold the energy of unit current.

Now, water acts as a vehicle of energy by virtue of its *mass*. If, then, electricity is an "incompressible fluid," how does it come to pass that the energy of the electric current varies as the *square* instead of the *cube* of the current? Is there any way to explain it on the assumption that some other property than mass is efficient in the case?

In the second place, the electric current is plainly not a flow of "energy," for it cannot be that the energy of a current of energy varies as the square of the current.

In the third and last place, let us see how far an electric current is analogous to a sound current.

The idea can be given by making some suppositions and drawing inferences from them. Suppose, first, that the human ear were sensitive to sound of a given pitch only, and that sound had become a commercial quantity, transferred by conductors. A meter could easily be constructed to measure amplitude of vibration, and so "current." If the apparatus at the transmitting end of the line were worked by a spring suitably mounted, energy would have to be used to keep the spring at the requisite "potential." On these suppositions we should have—

(1) Current proportional to potential.
(2) Energy required to maintain potential proportional to the square of the current.

Just as we have in the case of electricity. It is established that static electrification is closely allied to elastic stress, and why may it not be that dynamic electricity is amplitude of vibration of some medium or media? Perhaps the difficulty of making detailed descriptions of the mechanism of the operation may be insurmountable, but it can only be profitable to insist that such a fundamental fact as the relation of current to energy must be taken into account in our theorising.

* New York *Electrician and Electrical Engineer.*

THE TAVENER COULOMB METER.

Prof. E. J. Houston, writing in the *Journal of the Franklin Institute*, describes several meters suitable for measuring alternating currents. Of the instruments discussed in this paper the Forbes meter is already familiar to our readers, and the description of the Jehl and Rupp meter is taken from our issue of September 23rd, 1887; but a meter devised by Mr. Joseph Tavener and described in an English patent (No. 123, 1884) is new to us, and possesses features of interest. The description given by Prof. Houston is as follows:—

In this meter, a double-bulbed glass tube, similar in shape to the ordinary differential thermometer, has a wire spiral in each bulb, so connected that the current to be measured can be passed alternately through the wire in each bulb.

The apparatus is poised at its centre of gravity. The current being passed through the wire in one bulb expands the air, which drives a mercury column into the other bulb. This, now, being weighted, descends, making contacts which divert the current to the other bulb. An alternate see-saw motion is thus produced, and is measured by suitable counting apparatus.

The principles involved in the operation of the Tavener meter are very clearly put forth by the inventor in his provisional specifications, as follows:—

A tube terminating in bulbs, similar in principle to a differential air thermometer, but having platinum wire or other substance, of

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sufficient resistance to generate heat on the passage of a current of electricity through it, inserted through each bulb; the whole being partly filled with a fluid, such as mercury, and hermetically sealed.

This tube with bulbs, &c., rests on a support, at a point intermediate between the bulbs, and may be regarded as a hollow lever, whose support is its fulcrum, on which it turns, and whose equilibrium can be disturbed by the displacement of the contained fluid.

The whole is so metallically connected up and arranged, that on inserting it in a circuit the electric current will first traverse one bulb, heating the resistance, expanding the air, driving the fluid to the other bulb, making that heaviest, turning the lever, breaking connection with the one bulb, making connection with the other, heating the resistance contained in that, and in a similar manner again turning the lever—this action continuing so long as the current passes, but its frequency being dependent on the heat generated, which is equal to the product of the electromotive force into the quantity of current passing.

THE ELECTRIC LIGHTING OF THE CRITERION THEATRE.

The electric light has up to the present been adopted in four only of the London theatres, viz.:—The Criterion, the Savoy, the Prince of Wales's, and Terry's new theatre in the Strand.

We propose to give some account of each of these installations, commencing now with the Criterion. This theatre is lighted by about 500 incandescent lamps, and the restaurant by between 650 and 700. The lamps are supplied from 6 Edison-Hopkinson dynamos, placed in the basement below the restaurant. Five of these are used at night, the sixth being kept as a spare machine, and for use if required during the day time.

The dynamos are driven by two Armington-Sims engines of 100 indicated horse-power each, and give an E.M.F. of 105 volts at a speed of 850 revolutions.

The theatre lights are on two main circuits. The first of these includes all the stage lights, viz., 48 footlights in two main circuits, 204 lamps on six battens suspended from the ceiling of the stage, these being in six circuits, 34 proscenium lights in two circuits, and eight wing ladders carrying 80 lamps. This circuit also supplies 59 lamps on the dome of the auditorium, so that in case of one circuit breaking down the auditorium would not be left in darkness. These lamps alone if used at their full power would be sufficient to light the auditorium brilliantly.

The second circuit, which also supplies the restaurant, carries 56 lamps in the main corridor, 21 in the pit corridor, and 83 in the auditorium, arranged in three circuits.

Double-pole Edison safety fuses are placed in the switch room on each minor circuit, and wherever practicable and desirable additional fuses are placed; each of the wing ladders has its own fuse, in addition to that in the switch room.

On the occasion of our visit we were enabled through, the courtesy of the engineer in charge, to ascertain practically that the fuses were in efficient order; a small circuit containing five lamps was short-circuited as a test, and the fuse was immediately destroyed, throwing the lamps out of circuit. A single gas jet is usually kept burning in the centre of the dome, so that the jets there could be lighted at once in case of a breakdown of both circuits; but it is in a position in which it could not possibly cause danger from fire. The only other gas lights used during performances are one in a lavatory and the other on a staircase used by the company; they are both protected and so placed that it would be quite impossible for danger to arise from them.

Whenever two wires cross each other close together one of the wires is enclosed in an india rubber tube, in addition to the ordinary insulation. The connections with the wing ladders which are used for suspending on the scenery are made by covered wires, enclosed in india rubber tubes, which are passed through the stage floor and connected underneath. When the lights have to be lowered it is done in the ordinary way by the introduction of extra resistance. The whole arrangements are carried out in such a manner as to secure absolute immunity from fire as far as the lighting system is concerned. The glass of the lamps in the auditorium and corridors is ground or stippled, and is not in the least dazzling. The lamps in the dress circle and in the pit are let into the roof, and the light is thrown downwards by conical reflectors of opaque glass, producing a very agreeable light. We found the theatre wonderfully cool during the hottest part of last summer. This was no doubt due in part to the theatre being entirely below the ground level, but it certainly would not have been the case if the theatre had been lighted by gas. The electric light was first used on the 16th April, 1884, and the installation has worked satisfactorily since then without intermission.

ELECTRIC PUMPING IN COLLIERIES.*

BY FRANK BRAIN.

Before electricity is adopted by practical mining engineers, they must be convinced that it can compete economically with other methods of transmitting energy which are well known and generally applied. What percentage of indicated steam power applied to the generating electric machine is given off ultimately as available energy for mechanical work? How does it compare as to cost? Under what circumstances would its application be economical? If questions such as these can be plainly and satisfactorily answered, practical men will not be long in arriving at a favourable opinion and acting upon it.

The application of electricity to underground pumping has enabled the writer to tabulate some particulars which he believes will go a long way towards satisfying inquiries that this is a method of transmitting energy capable of wide and economical adaptation.

Some four years ago Mr. W. B. Brain described to this institute, in a short paper, a small electric pumping plant at Trafalgar Colliery, Forest of Dean, doing the work of about 1½ horse-power. This, the writer believes, was the first attempt ever made at pumping in mines by electricity. It has continued working satisfactorily up to the present time. A similar set, using about 2½ horse-power, has been working in another part of the mine, some 800 yards from the surface, for the past one and a-half year. Both are doing excellent service, removing small quantities of water from remote parts of abandoned workings, which, for the safe working of the colliery, must be kept free from accumulations of water. It may be well to say the majority of the collieries in the Forest of Dean have their shafts sunk on the "rise" of the taking, and the coal is won by "dipples," or engine planes, going full dip with the strata. The outcrop is riddled with old abandoned workings. These receive a great quantity of surface water, which finds its way down the slope of the strata to the deeper workings now in operation. The two electric pumps above referred to intercept some of this water on its downward course. The electrical pumping plant which the writer purposes describing in this paper has been put in to deal with the main come of water in the deep workings of the Trafalgar Colliery. The pump and motor are placed a distance of about 1,650 yards from the bottom of the shafts, and the water has to be forced by this pump a vertical height of 300ft. to the pit bottom. This water had previous to May last been coped with by one of Hathorn-Davey's water-power pumps, working in conjunction with a 7in. double plunger Manchester Pearn pump, with 10in. steam cylinders and 14in. stroke, the steam being obtained from the tubular boilers fixed underground.

The present pump—a double 9in. plunger with 10in. stroke—has been specially designed by the Lilleshall Iron Company (Limited) from sketches furnished by the writer, and is fitted with spur gearing running six to one. It is driven by a leather link belt, running off a 5ft. 9in. pulley, keyed on the same shaft as the spur pinion to a 14in. pulley on motor shaft. Thus, when the motor is running at about 650 revolutions per minute the pump is making 25 revolutions. The motor, supplied by Elwell-Parker, of Wolverhampton, is described as one of their 12in. machines—maximum speed about 650 revolutions per minute, output about 13,000 watts. The electric current is conveyed to it by a copper cable 2,000 yards long 19/16 wires, wrapped with compounded tape, and was supplied by the India Rubber, Gutta Percha, and Telegraph Works Company, Silvertown. This is enclosed in wooden boxes in the pit shaft only. It is supported upon earthenware insulators, placed at intervals of about 10 yards along the side of the underground roads. The return cable is an old iron pit rope about 4in. in circumference stapled to the road posts. The generator, placed on surface near the top of the shaft, is another of Elwell-Parker's 12in. machines. Its maximum speed is about 950, and output 17,000 watts. A belt communicates the power from a 12in. pulley on the generator to a 5ft. 11in. pulley attached to the crank shaft of an engine. The steam engine has a single 16in. cylinder with 12in. stroke, and works with about 35lb. steam pressure.

It is an old marine engine, picked up some time since at an auction sale, and is not what one would purchase new for the work. It indicated running empty a loss of 5 horse-power, the valves and piston being both the worse for wear. In the same engine house is another engine, which supplies the power for the two small electric pumps previously referred to. The steam for both is obtained from the range of colliery boilers near. A small insulated copper wire connected to a battery of eight No. 3 Leclanché cells connects the engine house with the pump house underground, and through this is registered upon a belt in the former each stroke of the pump. It is also used as a telephone line, so that a conversation can at any time be carried on between the engine-man on the surface and the man in charge of the pump underground. The two smaller pumps are locked up, with no one in charge, only being

* Paper read before the South Wales Society of Engineers, Cardiff, 24th November, 1887.

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visited occasionally; but with the larger one someone is thought necessary, although there is rarely anything more to be done than oil the machinery, adjust the machine brushes, and turn on the current. Near the engine the necessary electrical instruments, a voltmeter and an ammeter, are placed, by which the engineman knows the machines and cables are working properly. A magnetic cut-out is also placed in the main circuit, so that should the current through any unforeseen cause increase, it automatically breaks the circuit, thus preventing the flow of electricity through the cables. The maximum speed at which the pump has been driven is twenty-five strokes (114 gallons) per minute. The observations taken at the time were:—

Indicated horse-power of steam-engine	29·49
Speed of generator	900
Volts (at terminals of generator)	320
Amperes ,, ,,	43
Speed of motor	650
Volts (at terminals of motor)	260
Amperes ,, ,,	43
Actual horse-power of water lifted	10·36

The first diagram exhibited is prepared from the above figures, and shows the total loss of power—19·13 horse-power—to be apportioned thus:—

Loss in engine	6·49 horse-power,	or 22 per cent.
Loss in generator	4·56 ,,	or 16 ,, ,,
Loss in line	3·45 ,,	or 11 ,, ,,
Loss in motor	3·00 ,,	or 10 ,, ,,
Loss in pump	1·63 ,,	or 6 ,, ,,
	19·13	65 per cent.

The actual proportion of power given off by steam engine used to lift water is therefore 35 per cent. A second diagram shows the percentage of useful effect extracted from the power received at each stage, together with the percentage of loss—thus, horse-power indicated by steam engine 29·49:—

			Per cent.	Useful effect. Per c.
Received by generator	23·00 h.-p.,	loss in steam engine	22	78
,, cables	18·44 ,,	,, generator	20	80
,, motor	14·99 ,,	,, cables	20	80
,, pump	11·99 ,,	,, motor	20	80
,, water	10·36 ,,	,, pump	14	86

A third diagram shows the loss between the power given off at the belt of the steam engine and the actual work done, thus:—

Horse-power given off to generator		23·00	
Loss in generator	4·56 horse power, or 20 per cent.	20	55%
Loss in cables	3·45 ,, ,, ,,	15	
Loss in motor	3·00 ,, ,, ,,	13	
Loss in pump	1·63 ,, ,, ,,	7	

The proportion of power given off by belt used to lift water is therefore 45 per cent. As to cost, the writer has been to considerable pains to verify the following figures, knowing that with business men this is the crucial test. The following is a summary of the first cost of the plant:—

	£	s.	d.
Two electric machines	£310	0	0
Insulated copper lead	138	0	0
Return wire-iron rope	25	0	0
Signal wire	10	0	0
Insulators	6	0	0
Steam engine (estimate)	140	0	0
Fixing and sundries	15	0	0
	£644	0	0

The pump (£130) and pipes are not added to the above, seeing this item of cost would of necessity be part of any set of plant, and it would therefore be an item of cost common to all systems.

Detailed cost of pumping 114 gallons per minute with above machinery through 1,300 yards 7in. pipes, main rising 300ft., one week's pumping, 22 hours per day:—

	£	s.	d.
Engineers (half-time)	£1	8	0
Man underground (full time)	2	9	0
Small coal consumed, say 36 tons at 1s.	1	16	0
Oil, waste, and sundries	0	7	0
Say 15 per cent.	1	17	0
	£7	17	0

Cost per horse-power on water raised, 0·2 of a penny. Cost per 1,000 gallons of water raised, 1·80 pence.

The come of water in the deep workings of the colliery has been much below the average during the past dry autumn. The pump has therefore been usually worked at about 64 gallons per minute. The results, of course, not being so good, are as follows:—

Proportion of power generated used to lift water, 32 per cent.; cost per horse-power in water raised, 0·3 of a penny; cost per 1,000 gallons of water raised, 3d. When opportunity offers and the hold of water is pumped out this plant is utilised to assist in maintaining the ventilation. Some 1,200 yards underground a small fan, passing some 10,000 cubic feet of air per minute, is placed in a return air way. A branch connection is made from the main cable to an electric motor, which drives the fan by belt connection. The cost of maintaining the present plant, compared with that it has supplanted, shows an economy of about £470 per annum. This, the writer does not, however, rely upon as a fair comparison of cost, seeing that the former plant had to be worked under most disadvantageous circumstances.

The whole of this plant was supplied by the various makers to specification, and was put in by the colliery mechanics without any outside assistance. It commenced working without a single hitch, and has worked continuously since the end of May last with but one accident. This, strictly speaking, cannot be spoken of as an accident. A couple of weeks ago, we found much more current was being taken to do the ordinary work than usual, and on examination traced the cause to the cable in the pit shaft.

Here, as already explained, the cables, which are not highly insulated, are carried in wooden troughs. The late continuous heavy rains had very much increased the feeders of water in the shaft, and this water, finding its way into the boxes, saturated the cables, causing a great escape of current. A lead-covered cable was substituted for the ordinary one, and the difficulty was completely overcome.

The cable was a matter of some anxiety when the plant was being provided, as the writer feared that falls, which cannot be prevented on underground roads, would be constantly damaging it and causing delays. In practice, this has never yet been found to occur. With the one line indestructible (as the iron pit rope practically is) the other, should it be damaged, can quickly and easily be repaired, or replaced with new, so that this, one of the most formidable of the anticipated, difficulties has proved quite illusory. The plan which has been adopted of supporting the cable upon earthenware insulators has proved a good one, more perfect insulation—a very important factor—being obtained. The repairs necessary to the side timber of the roads along which the cables are suspended is also facilitated.

The commutators are the principal electrical wearing parts, and with care these will run a considerable time. In this instance, after five months' work, the wear shown is only about one-sixteenth of an inch, although there is an inch thickness of copper to be worn away before it is necessary to have a new one. With a spare armature kept in hand, which costs about one-third the price of a machine, no accident can happen which the colliery mechanics cannot repair, and that with little delay, everything being simple in construction and easily to be got at.

It is an advantage which colliery managers will appreciate to concentrate work and have it under personal supervision. Given sufficient engine power, any reasonable number of generators can be driven in one engine house on surface, delivering power to distant places underground at various points of the compass. These dynamos would require but one man to attend to them, and the work done could with ease be supervised. The steam, too, can be generated at least possible cost under such circumstances, and with the work divided between two or three engines a breakdown with either—should it occur—need not cause any delay. It is especially noticeable that this plant can be put down economically and with great despatch. With pipes carrying steam-compressed air or water it is often necessary to place them in ditches specially made at considerable expense along the sides of the underground roads, so as to protect them from injury and keep them out of the way.

The outlay in pipes is also great, more especially when the route is devious, and if the roads are at all given to "puck" these are constantly being broken. With electric cables none of these difficulties occur. No matter how intricate the route may be a thousand or two thousand yards can be put to work in as many hours as it would require weeks to put in pipes. Given a pump with the necessary suction and delivery pipes fixed a mile underground, with steam power available on the surface, it would be practicable to have that pump in work in less than a week, an impossibility with any other method. The drawing attached gives a side view of the generator in the surface engine house and of the motor and pump in the underground engine-house, together with a plan of the latter. Another one shows the method of suspending the cables.

A few brief extracts from papers already put, tested, comparing the cost of electricity with the power derived from steam, compressed air, or hydraulics may be interesting.

The following is given by Prof. Schulz* (*Proceedings* Institute Civil Engineers, Vol. LXXVIII., page 67, and *Transactions* North of England Institute of Engineers, Vol. XXXIV., page 5.

* See also *Electrician*, April 1st, 1887.

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Total cost of underground haulage by locomotive.

	Per ton in pence.
Steam engine	1·0
Electric engine	1·54
Compressed air engine	2·06

Total cost of various systems of underground haulage.

	Per ton in pence.
Endless chain	0·98
Rope and counter rope	1·26
Electric locomotive	1·54
Rope and tail rope	1·89
Endless rope	2·83

A comparison between electric transmission and mechanical methods was published in Berlin in 1883 by A. Beringer,* and awarded a prize by the Electro-Technical Society there.

A *résumé* of it appears in the *Revue Universelle des Mines* (Series 2, Vol. XV., p. 522). The following brief extract may be of interest:—

Comparison of cost on 10 effective horse-power-hours transmitted 1,093 yards.

By cables	1·77	pence per effective horse-power per hour.
By electricity	2·21	,, ,, ,, ,,
By hydraulics	2·90	,, ,, ,, ,,
By compressed air	2·98	,, ,, ,, ,,

Comparison of cost on 50 effective horse-power-hours transmitted same distance.

By cables	1·35	pence per effective horse-power per hour.
By hydraulics	1·87	,, ,, ,, ,,
By electricity	2·07	,, ,, ,, ,,
By compressed air	2·27	,, ,, ,, ,,

Comparison of cost on 10 effective horse-power-hours transmitted 5,465 yards.

By electricity	2·64	pence per effective horse-power per hour.
By compressed air	4·66	,, ,, ,, ,,
By cables	4·69	,, ,, ,, ,,
By hydraulics	5·29	,, ,, ,, ,,

Comparison of cost on 50 effective horse-power-hours transmitted 5,465 yards.

By electricity	2·37	pence per effective horse-power per hour.
By cables	2·65	,, ,, ,, ,,
By compressed air	2·99	,, ,, ,, ,,
By hydraulics	3·02	,, ,, ,, ,,

Steam was the prime motor used in each instance.

From the above figures it is inferred that for distances of about 1,000 yards cable transmission costs least, but that in longer distances electricity takes the lead and maintains it against all other systems.

The cost per effective horse-power per hour of the electrical pumping plant herein described is found by the figures as to cost already given to be 1·18 pence. It is obvious a future is before electricity in the transmission of power. For coal cutting it affords a ready means of distributing power, for hauling engines, which can either be stationary or run to various parts of the colliery on prepared tracks, as well as in pumping; this new motive power must take a place, and that no despicable one, in the future of colliery working.

* See *Electrician*, April 1st, 1887.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Dec. 1st*, 1887.

It may perhaps be remembered by your readers that quite a sensation was created recently by the granting of certain telephonic and other concessions in China to a syndicate of American capitalists. Steps have recently been taken to exploit and improve the concession granted, and it is said that a large amount of American capital is likely to become invested in this way in supplying the inhabitants of the Celestial kingdom with telephones and other conveniences of modern civilisation. It has been understood here that the award of this concession has awakened various English and foreign jealousies. It may also be said to have aroused cupidity here at home.

Mr. Chester Holcomb, of Pekin, at one time attached to the American Legation there, is now in Chicago, and he claims to hold valuable Imperial letters patent, in comparison with which the Mitkiewicz grants sink into insignificance; in fact, he goes so far as to say that Count Mitkiewicz holds nothing but a memorandum drawn up by some Government underling. However this may be, Mr. Holcomb and his friends propose to proceed at once to the development of Chinese resources.

The question of Government control of the telegraph is steadily coming to the front, and it promises to be ere long a prominent political issue. It may even have some bearing on the Presidential campaign next year. The Senators and Representatives now assembling in Washington for the next Congress betray a lively interest in the subject, seeking information in every quarter, and many of them come armed with Bills and legislative projects dealing with the subject. More than this, the Knights of Labour have taken a hand in the matter, and are said to favour Government control well nigh unanimously. Mr. T. V. Powderley, the General Master Workman of the Order, is giving no small amount of attention to the question, and has been in New York this week securing all the data available on it, including English blue books and official documents. He has also been in consultation with Mr. T. O'Reilly, who is at the head of the brotherhood of operators in this country. Mr. Powderley says that his Order is determined to put forth all its energies in this direction, so that if possible the desired change may become an accomplished fact during the next Session of Congress. The details of the scheme that the Knights of Labour are likely to favour have not been published. If the Knights stand with the Brotherhood they are hardly likely to propose to buy out the Western Union Company, and yet some such course would seem necessary if steps are taken to put an end to private ownership of telegraphs.

The rigour of our American winters, when the ground becomes as hard as a rock at a depth of several feet, prevents any furtherance of subway work until the return of spring. You have already made note of what has been accomplished in this city by the Board of Electrical Control in burying the wires, and the Board has certainly done a good deal of work; but it is said that the past year has actually seen an increase in the quantity of overhead wires, so rapid has been the extension of various services in the newer districts. One of the most important features of the work done during the past autumn has been the preparation of a very large section of uptown New York, including most of the finest hotels, restaurants, theatres, churches, public halls, and private residences, for service from the Edison system. The district is bounded by 18th and 59th-streets, and by 3rd and 8th-avenues. At a rough guess this district accommodates a population of about half a million, and is at present the most wealthy and respectable portion of the city. In this territory the Edison Company will have three stations. The first of these is already under construction in 26th-street, near 6th-avenue, and it will be in operation by the beginning of the year. It will be a notable building in many respects, handsome though not too ornate, but in every way massive and safe. As far as can be now learned, no provision is made for storage batteries to supplement the plant, but special pains have been taken to secure several hours' reserve of both coal and water. It may be mentioned that the boilers and engines are at the top of the building, and that coal and water will be stored above them. The station will be equipped with a new form of Edison dynamo, and an improved type of Armington and Sims engine. This station will have a capacity of 30,000 lights. When all three stations are in full blast, as they undoubtedly will be in the near future, they will feed at least 100,000 Edison lamps, and the district will be wired up for at least 170,000. It will thus be seen that in New York, at least, we are rapidly approaching the time when electricity is to gain its rightful position as the best means of interior and domestic illumination. It should be added that within this large district a considerable quantity of electric power will be distributed from these stations in the day time by Sprague motors.

Great improvements have been made in this country of late years in the manufacture of wire for electrical purposes. Some

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remarkable developments have been attained of late with silicon-bronze wire. I saw this week a sample of this wire made by the Scorill Manufacturing Company, of Waterbury, which had withstood a twisting test of over 100 turns in six inches. I believe silicon bronze wire already enjoys considerable vogue in Europe. It now promises to command a place of its own in America.

Few things have been more remarkable than the extraordinary rate at which the alternating current system of electric lighting has been introduced and put in operation in all parts of the United States. There is hardly anything to compare with it. The Westinghouse Company has been making contracts for plants of this system at the rate of about 20,000 or 30,000 lights a month, and the demand seems to grow rather than to fall off. With so rapid a rate of introduction it is but natural that some careless work in wiring should be done, and as a result there have been several accidents in the use of the system. How far these are due to the inherent defects and dangers of the system, or may be ascribed to careless work in insulation, continues to be a matter of lively dispute. Meantime this rapid commercial development has stimulated interest in the scientific questions connected with the subject, and whatever literature exists with regard to it is read with great avidity. Mr. William Stanley, jun., electrician to the Westinghouse Company, has for two or three years been devoting his attention almost exclusively to a study of the alternating current and its phenomena, and he intends to bring some results of his investigations before the American Institute of Electrical Engineers next week.

It has been very gratifying to all well-wishers of the electric light to see that so extensive a plant has been put in operation at Leamington. It is regarded here as of the brightest augury that so shrewd and representative a family as that of the Chamberlains should be actively represented in the enterprise. It is hoped that the work may not stop at Leamington, but that that city may simply serve as the turning point in the tide. It is thought a little singular that the gas companies in England have as yet shown so little desire to concern themselves with electric light supply. In America the tendency is so markedly in the other direction that it is safe to predict that the vast majority of gas companies in this country will before 1890 be operating electric light plants, both arc and incandescent.

CORRESPONDENCE.

DISEASES OF DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of December 2nd I notice that Prof. S. P. Thompson is reported to have said that "unequal fields were often the cause of sparking, and on this account double magnets had an advantage," and in your issue of December 9th Mr. W. B. Esson, in his letter on the above subject, mentioned the fact that in single horseshoe field-magnets more lines go through that half of the armature nearest to the yoke than through the farther half. He then goes on to suggest a means of equalising the flow of lines in the single circuit machines.

These statements inferentially cast a stigma on the single horseshoe field-magnet which is by no means deserved. Sparking at the brushes is no more likely to occur in a machine with a single horseshoe field than in one having a double field. The current being collected from the armature coils by a brush will not cause sparking provided that lines of force are being cut by the coil at the time when it passes under the brush, such number of lines being just sufficient to neutralise the E.M.F. of self-induction in the coil caused by the reversal of the current which it is carrying. In a double horseshoe field the amount of lead at which all sparking ceases at one brush will be approximately correct for the other brush; but in a single horseshoe field (inverted Edison field) the upper brush will require rather more lead than the lower—that is all. Both types of field are equally good if the brushes are properly adjusted as regards non-sparking. And in other respects the single horseshoe machine offers some advantages. The current idea that the brushes of *all* machines should be set on a diameter is fallacious; obviously, the brushes of machines having ring armatures should be set independently.—Yours, &c.,
J. G. STATTER.

West Drayton, December 14, 1887.

PRIMARY BATTERIES FOR HOUSE LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. N. G. Thompson has supplied you with a table intended to show the comparative cost of engine power and primary batteries; but, as regards the latter, he has been unfortunately misled by the figures as reported in Mr. Nursey's paper, upon which he founds his calculations, and a more careful examination of those figures will alone require him to decrease his estimate of the cost of a battery by nearly one half. Should he so examine them, he will perceive that ten 10-candle lamps of 30 watts each, burning for 20 hours, represent 6,000 watts, or rather more than eight electrical horse-power-hours instead of five, over which to spread the cost of the liquids used during that time; and again, he will hardly need to be reminded that the cost of the outer (or zinc) liquid, once incurred, does not need to be repeated every 20 hours, nor even every 20 weeks, so that it may be taken as so mere a fraction of a farthing per horse-power-hour that it can safely be eliminated from the estimate.

Following, then, Mr. Nursey's figures, this reduces the cost of the "fuel" to 6d. for the zinc (which is taken at 50 per cent. above its wholesale price) and 6¾d. for the liquids, or a total of 12·75d. per horse-power-hour, instead of the 20·40d. inserted in Mr. Thompson's column under the heading of the "working cost of battery."

He errs equally in the opposite direction as regards the cost of a dynamo and engine for small installations, which is ground so shifting that upon it even angels would fear to tread. Their average cost, as given in the parallel column, is estimated at about 1s. per horse-power-hour when coal or gas is supplied to an engine for five hours daily, or 1s. 6d. when they are supplied for three hours daily. But these figures merely cover the wages at 30s. a week of one engine driver and the cost of the fuel used during those hours, which is not by any means the same thing as keeping the lamps lighted—as in his estimate of the battery cost—during the same number of hours, for neither is steam got up instantaneously wherewith to work an engine, nor can a gas-engine be used for the supply of a steady current to 24 incandescent lamps without intermediate accumulators requiring further time to charge them. Moreover, the installation in the cellar of a private house of engines and dynamos, generally involves expensive foundation works, &c., and nothing is put down for the annual interest on capital, for wear and tear, or for the frequent renewal of brushes.

In a recent instance with which I am acquainted, as much as £900 has been expended on the installation in London of a very unsatisfying 2 horse-power gas-engine and the corresponding dynamo and accumulators, where equal or superior battery efficiency would have been attained at a cost of £100.—Yours, &c.,
O. C. D. ROSS.

P.S.—Four shillings per week for labour is excessive with such a battery as I described at the meeting of the Society of Engineers, in which all the cells "feed themselves" from surrounding liquid.

THE CONDUCTIVITY OF GLASS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I do not wish to enter into any personal controversy with Mr. Proctor, but after his letter published in your last week's issue I must ask you to permit me to add one or two observations.

Mr. Proctor will no doubt recollect that I was always perfectly free and open with him in the discussion of any experimental work on hand, and I have no doubt he remembers as

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well as I do how he aided me in carrying out the experiments to which I referred.

We freely discussed every part of the question together, but I certainly have no recollection that it was he who *first* suggested to me that the blackening was due to electrolytic action, or I should have attributed the observation to him.

It was one of the pump hands who first pointed out the persistency with which the blackening occurred on one side, and this observation it was which really gave the clue to the whole matter.

In writing my note on the subject, I was careful to word it so as not to claim for myself any credit that I did not consider belonged to me, but I do not think in writing a simple note on a scientific subject you want the whole history of the development of the idea; though if there is any special credit due to Mr. Proctor, I am sorry not to have given it to him. Mr. Stearn's reply to Mr. Proctor's letter, however, appears to indicate that, at a time when he (Mr. Proctor) was supposed to be aiding me, and when the whole matter was a frequent subject of conversation and free comment between us, he was writing, unknown to me, to our superior officer and calmly claiming the entire credit of the observations for himself!—Yours, &c., NELSON K. CHERRILL.

AN INQUIRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can you or any of your readers kindly tell me of any means by which I can obtain an instantaneous electrical contact from the sun, so that I can get solar time any day?—Yours, &c., W. HARDY, JUN.

Mistleton, Oakham, Dec. 10, 1887.

PHYSICAL SOCIETY.

At the meeting of the Physical Society on the 10th inst., Dr. R. C. Shettle read a paper entitled "Rotation of a Copper Sphere and of Copper Wire Helices when Freely Suspended in a Magnetic Field."

The experiments shown were of a novel character, and excited considerable interest. A copper sphere was suspended close to the pole of an electro-magnet, and when the magnet was excited it slowly turned through a considerable angle, and ultimately came to rest, returning to its original position—determined by the torsion of the suspending fibre—when the current was turned off. The direction of motion was independent of the direction of the current.

Dr. HOFFORD, who had seen Dr. Shettle's experiments the day before, devised an experiment in illustration of the same action, which he exhibited to the society. He suspended a copper disc, punched out of a sheet of copper, in a horizontal position between the poles of an electro-magnet. When the magnet was excited a deflection was found to take place which, as in Dr. Shettle's experiments, was independent of the direction of the current. Dr. Hofford also found that within the limits of a hastily-devised experiment the deflection was not appreciably affected by removing one of the pole-pieces of the magnet. The effect cannot be due to induced currents in the copper, since the deflection is permanent with a steady current. Dr. Hofford was inclined to attribute it to dia-magnetic action, due to want of homogeneity in the copper. It might also be due to the presence of iron or its magnetic equivalent in the copper. Which of these two explanations is the correct one may easily be decided by allowing the metal to oscillate in presence of the excited magnet, and determining the logarithmic decrement, which would decide whether or no the effect was due to induced magnetisation.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

ANNUAL GENERAL MEETING, DECEMBER 9.

The annual report read and adopted at this meeting, besides announcing the award of prizes to Messrs. Kennelly, Sumpner, and Fleetwood, as reported in our last issue, went on to state that the several committees of the Society having under consideration the subjects of electrical nomenclature, the formation of a standardising laboratory, and a revision of the rules relating to fire risks, were approaching the completion of their labours, and that their reports would probably appear very shortly. A noticeable increase in the number of students was a matter for congratulation, and the Society had determined that the papers read at the Students' Meetings should be eligible for the prizes at the Council's disposal, the same as papers read before the Society's ordinary meetings. Subscriptions invited towards the Imperial Institute had amounted to £71. The Jubilee Fund for the improvement of the Society's library had now reached £172. The hon. secretaryship, vacant by the decease of Colonel Frank Bolton, was not to be filled; and in future the duties of Mr. Frost, the late librarian, also deceased, would be performed by the Society's secretary, Mr. F. H. Webb. The Council had under consideration the advisability of changing the title of the Society, and were of opinion that the "Institution of Electrical Engineers" would, in the changed circumstances and the time, be a fitter title than the one borne by the Society at present. This matter will, however, be submitted to the members before any decisive steps are taken.

After the usual votes of thanks to the Institution of Civil Engineers for the continued use of their theatre, and the foreign hon. secs., the hon. treasurer, and solicitor, a paper was read by Mr. A. C. COCKBURN, F.C.S., on "Safety Fuses for Electric Light Circuits, and on the Fusing Points of Various Metals Employed in Their Construction." The paper was profusely illustrated by diagrams and apparatus, many experiments with various kinds of fuses being shown in the course of the evening.

We hope to give a full report of this paper in due course.

DISCUSSION ON MEASURING INSTRUMENTS AT THE SOCIETY OF TELEGRAPH-ENGINEERS.

(Concluded from page 112.)

Mr. SWINBURNE said they were all very glad Dr. Fleming and Mr. Gimingham had brought out their instrument, chiefly because it would be most carefully calibrated. As a rule bad calibration was the weak point of an instrument, more than bad design or bad construction. The first thing in the way of criticism that struck one in that instrument was the method of bringing in the current. He had tried wattmeters with two springs, pivoted, one to bring in the current and the other to bring it out again, and he might say he could find no trouble in it. The current was necessarily small, and the surface of the springs was very large. He did not know anything about the temperature coefficient of springs, but taking the percentage of error in the watch it was not very great; it was too small to affect an instrument of that sort. Another thing in looking at that instrument which struck one was the ingenious way in which coils were brought into a state of equilibrium. Those who had spent time in designing instruments in which large force was required for small expenditure of energy, had found that nearly all the methods which struck one had coils in a state of unstable equilibrium. He was glad to see the spring was used again in instruments, and he would also like to see the prejudice against permanent magnets removed. The advantages of using them were so great that they ought to come into general use. He did not know whether Dr. Fleming proposed to use his instrument for alternating currents. Coming to Profs. Ayrton and Perry's instrument, he always went for Prof. Ayrton whenever he got a chance, partly on principle, and partly because he liked it (laughter). He thought everybody would like to have discovered the heated wire of Capt. Cardew, and everybody wished very much indeed that he had invented that spiral spring arrangement, for with the two things combined they seemed to get perfection (hear, hear).

Colonel ARMSTRONG asked the effect of external changes of temperature on the instruments. He would also like to know to what extent they had been used, and with what degree of accuracy they worked.

Captain SANKEY asked Prof. Ayrton what kind of fuse he used.

Mr. GUMPEL was of opinion that Dr. Fleming's instrument was not the instrument of the future for general use or for the workshop. He would like to ask Prof. Ayrton what influence repeated tension or contraction of the platinoid wire against the spring had on the accuracy of the instrument.

After a few words from Mr. GIMINGHAM, Mr. GISBERT KAPP, and Mr. SPAGNOLETTI,

Dr. FLEMING replied: He expressed his and Mr. Gimingham's sincere thanks for the kind way in which the paper had been received and for the valuable criticisms which had been passed. He agreed entirely with a great many things Mr. Gordon had said on the last occasion. One of the most pressing wants was a really good engine room voltmeter, one that could be seen across a large room. The instrument they had brought forward was of the same type as that of Mr. Siemens. The principle was not new, and the first person to arrange an electro-dynamometer was Weber, about 1846. He was very glad to see the instrument designed by Sir W. Thomson on the table. They had one of his standard current meters in their laboratory, and they used it constantly. It was a very beautiful instrument, and it could not but be so when they recollected the immense ingenuity and wonderful theoretical knowledge which Sir W. Thomson brought to bear on all that he did. At the same time it could not be denied that the instruments were not convenient as portable standards. They required very careful arranging, and he (Dr. Fleming) used them as standards for checking other instruments. He endorsed the remarks that it would be difficult to get a reading if the current was in the slightest degree unsteady. With respect to the

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effect of the current on the elasticity of the spring, the objections raised seemed to be formidable in theory, but they did not turn out to be very great difficulties in practice. They had tested the instruments by keeping the current on them for some time, and they had found that when the instrument had been kept on the circuit for some time there was no alteration of reading due to the change in the elasticity of the spring within the limits in which the instruments were intended to read. He was very glad to hear Mr. Evershed's remarks, because they all knew that he had paid very great attention to the manufacture of electrical measuring instruments. He agreed that the instrument by being wound partly with copper and partly with platinoid might be made to take less power. One reason why German silver was used was to reduce the variation coefficient. Mr. Swinburne mentioned the fact of mutual induction between the currents increasing the self-induction of the instrument on the whole, and therefore it was not available for measuring alternating currents. The instrument was not put forward as meant for measuring alternating currents. Colonel Armstrong had asked to what degree of accuracy these instruments could be depended upon. The object which they had in view in designing the instrument was to make a portable standard which should be free from the objections which exist in instruments in which iron was used. It was possible to take a reading in the neighbourhood of 100 volts to about a quarter of a volt, or perhaps a little less; and the instruments were intended to be sensible within one part in four or five hundred, in that part of the scale which presumably they will be most used. Replying to Mr. Spagnoletti, he said the instruments had not been in the hands of the public but they had been thoroughly tested, and they were satisfied they had a portable and convenient form of electro-dynamometer, which was portable in this way—that there were no mercury cups to be filled, which were considerable objections. Although the instrument would not be used for marine purposes, or where a perfectly steady table cannot be secured, he thought they would be able to get over that objection by producing an instrument which would be free from any necessity of levelling. Dr. Fleming concluded his reply with some criticisms upon the instrument produced by Profs. Ayrton and Perry.

Prof. AYRTON said reference was not made in the paper to the extremely interesting instrument that Sir Wm. Siemens had introduced, and the reason why was that, although it was an instrument for the measuring of current, they did not wish, as they were using Captain Cardew's voltmeter principle, in any way to imply that Captain Cardew had been anticipated, or to detract in any way from the credit due to him for having used this principle for the measurement of volts. He had referred to the information supplied by Captain Cardew, and he thought of using the sag of the wire for the purpose of measuring volts, but, as he himself had said, without some such arrangement as the magnifying spring, it was impossible to use the principle for making commercial instruments. He was inclined to agree with Mr. Swinburne that such instruments as had been exhibited by Dr. Fleming could not be called direct reading instruments, and he thought the name should be kept for instruments in which the hands pointed to the reading exactly in the same way as a clock indicated the time. He was inclined to agree with Mr. Esson as to the wattmeter, and he thought that he had some right to criticise the wattmeter, because the first made in this country was made by his colleague and himself, and it was rather interesting how it was made public. There were two papers down for reading at the British Association in 1881, one by Sir William Thomson and the other by himself and Mr. Perry. As a matter of fact their paper came first, and Sir William Thomson's second, in the printed list. Sir William Thomson told them he had to go to a committee meeting, and asked if they had any objection to his reading his paper first. He described the principle of the wattmeter, and when their turn came Sir W. Thomson, chairman, called on them to read their paper. He (Mr. Ayrton) told him he had already read it, and there was the instrument which illustrated what he had said. He (Sir Wm. Thomson) had priority in reading the paper, and they had priority in producing the instrument. He had had no experience of Sir W. Thomson's current meter on the table, but like all his instruments it was no doubt extremely beautiful and accurate; but such instruments as these aimed at obtaining a totally different sort of results from those which they (Profs. Ayrton and Perry) had from time to time brought before the society. There was the same difference between that instrument and others on the table as there was between the astronomical clock at Greenwich and the watches they carried in their pockets. With reference to the question about the fuse wire, 0·4 mills, the finest wire they had used for the expanding wire in their voltmeters was 1·4 mills, while in some instruments it was 2 mills. Now, although this was much finer than the wire Captain Cardew employed generally in his voltmeters, viz., 2·5 mills, it was nevertheless much thicker than fuse wire, so that there was no difficulty on that head.

The PRESIDENT (interrupting): Can you use that form of dynamometer on board an electrical launch?

Prof. AYRTON: Certainly.

The PRESIDENT: In any kind of weather?

Prof. AYRTON: Yes. In any kind of weather, fair or rough, provided you do not suffer from *mal de mer* (laughter). Any weather suitable for yachting is suitable for that instrument. Captain Cardew, like many others, had suffered a great deal from the want of knowledge of the instrument makers, and he did not know that any of the instruments made had done him any particular amount of credit. On the matter of calibration a number of experiments were being carried out, and it was for that reason they had not introduced the compensation—which was quite easy to introduce. In order to introduce that compensation with certainty they required to know this fact: What is exactly the coefficient expansion of the platinoid silver under considerable tension? That acquired, there was not the slightest difficulty in compensating one of these instruments. Experiments had been made with the instruments. The wires had been warmed up many degrees centigrade, and they knew exactly the change of zero and of sensibility with temperature. The change at zero was about half a degree, or one degree. That was very small. In one instrument there was no change of sensibility. What they wanted to know was the exact coefficient of expansion of platinum silver with temperature, and when they had got that it was a mere question of calculation. As they would observe, instruments had been placed vertically instead of horizontally. A great deal had been said about the pointers not being visible enough; but people forgot that a watch was a very useful instrument, despite the fact that they could not see the hands at forty yards distance. Mr. Evershed had raised some interesting points as to the power expended with different wires, and to these and other questions raised he would reply in his written answer. At the last meeting an impression might have been introduced in the minds of some that he had brought an old specimen of the Cardew voltmeter with the idea of disparaging Captain Cardew's voltmeter. Nothing was further from his mind. He was under the impression that he was bringing a new form. He bought it as a new form. It had taken many months to make, had cost a lot of money, and had been sold to him as the most improved form of Cardew voltmeter.

On the motion of the Chairman, a cordial vote of thanks was passed to the authors of the paper.

THE BRADFORD CORPORATION AND THE ELECTRIC LIGHT.

At a meeting of the Corporation of Bradford, held on Tuesday last, a report of the Gas Committee came up for consideration, containing a recommendation to the Council to provide an installation for electric lighting in the borough over a certain area, at an estimated cost not exceeding £15,000.

Alderman F. PRIESTMAN moved the adoption of the minutes. He said he did not think it would be necessary for him to occupy much time, because this question was by no means a new one, and had been before the Council on different occasions during the last four or five years, but more particularly, perhaps, during the last twelve or eighteen months. He did not expect that any member of the Council would either think or say that the Gas Committee had brought this question forward with undue haste. He did not think that the delay which had occurred was by any means lost time, because without doubt a very important improvement had taken place in machinery for the generation of electricity, while in the matter of distribution the work was much better done now than was the case a few years ago. The Council might therefore with confidence spend its money with the certainty not only that the undertaking would be of a more permanent character, but that it would be more remunerative than would have been the case twelve months ago. Members of the Council would remember that in 1883—when electric lighting stood very high in public favour, and when companies were being formed not only in London but in almost every county of England, and when the shares of such companies went up to an enormous premium, and those of gas undertakings were correspondingly depressed—the Bradford Corporation went to London to resist an application on the part of a London company to supply Bradford with electricity, and at the same time they (the Corporation) went to London for a Provisional Order to give them the right to put down electric light in the borough. In both these applications the Corporation were successful. This order was still in force, and by a subsequent Act of Parliament the Corporation had very large powers conferred upon them. They had power to prevent any company from carrying their wires over any of the streets, so that at the present time they had absolute power to keep other companies out, and practically to do what they liked themselves. But these powers were granted to the Corporation on the understanding that they would be used, and they were not intended merely as a shield to prevent competition unless the Corporation did something—not intended, in fact, that they should refuse to allow any one to put down electric light, and at the same time to refuse to do it themselves. On the contrary, it was distinctly stated in their Provisional Order that if the Corporation vexatiously deferred taking action in the matter the powers might be granted to other persons. The committee thought the time had come when the Corporation must either do the work itself or grant powers to others, and he did not think there would be two opinions in the Council as to which was the better course. Alderman Priestman then went on to say that Messrs. Schmidt, Douglas and Co. (who have a small central station already at work in Bradford) had made overtures to the committee with regard to the purchase of their plant; but for various reasons, which were given at length, the committee were unable to recommend the Council to take this step. After the negotiations with them, the committee felt that they had no longer any alternative but to recommend the Council to put down an installation of their own. Although they asked for £15,000, it was not their intention to spend at the present time more than from £8,000 to £10,000. The winter months were

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already partly gone, and it was quite impossible to put down an installation for the whole of the town which would be of any use during the present winter. If, therefore, the Council sanctioned the expenditure proposed, the committee would put down a small installation, and test it during the spring and summer, afterwards applying to the Council for further powers if they thought it necessary to do so. Their plan was briefly this: They would erect a boiler house and an engine and dynamo house on land belonging to the Corporation in Holdsworth-street. They proposed to put down two or else three 150 horse-power engines, either compound or triple expansion, with dynamos of course sufficient for the power required. Their present intention was also to lay down two main cables—one along Market-street as far as the Town Hall, and the other up Kirkgate and Darley-street as far as the markets and the free library. The cables would be laid underground, either in brick trenches or a composition prepared for the purpose, and of course the services could be attached so as to supply the whole of the intervening property. The area embraced by the proposed installation was shown on this plan (producing plan), and it was rather curious that it exactly accorded, as Mr. Shoolbred had pointed out in a letter to him, with the powers obtained in the first Provisional Order. It was proposed that the electricity should be supplied at what was known as low pressure. That could be done within a certain radius of the station, and with electricity delivered at low pressure there was absolutely no danger to life or property from fire. As a consequence insurance companies did not charge any extra premium for insurance on buildings thus lighted. Of course a very important element in considering the probability of success in such an enterprise as was now proposed was the question of price. The committee hoped to be able to sell the electricity by measurement by meters, so that everyone who bought it would only pay for the quantity actually expended, instead of paying so much per lamp. Whether this could be done would, of course, depend very much upon whether the meters in existence were of sufficient accuracy by which to sell the illuminant. It had been stated that there was no meter sufficiently accurate for this purpose, but it appeared that there were six or seven sufficiently accurate to buy by. In a letter in one of the papers that day it was stated that there were at least six types of meter which were all accurate. He hoped the committee would find this to be true, for the result would be to remove from their shoulders a great amount of work, trouble, and anxiety. A unit of electricity was supposed to be equal to 100 cubic feet of gas, and by the Provisional Order a maximum charge was allowed of 7d. per unit, which would be equal to 5s. 10d. for 1,000 cubic feet of gas. The committee thought that 5d. would probably be the charge which they would have to make, which would be equal to 4s. 2d. for 1,000 cubic feet of gas, or a little less than double the present price of gas in Bradford. Many people in the town had said that if the price of electricity was only double the cost of gas they would be glad to adopt it. Mr. Priestman proceeded to say that the works which it was proposed to erect would be built in a permanent and substantial manner, and would form part of a comprehensive and complete plan, which could be fully carried out if found desirable. The committee had entered into no undertaking whatever with regard to dynamos, engines, or anything else; nor were they at all wedded to any particular plan. He had no doubt the discussion that day would result in offers of land not yet put in the market, and possibly the committee might get even a better and more central situation than that which he had named. They came before the Council, therefore, merely to ask that they might be allowed to go on in the best way they could to provide an installation of the kind which he had mentioned. He had no doubt that the Council would pass the resolution. If they did, the first duty of the Gas Supply Committee would be to appoint a subcommittee to visit London and Leamington for the purpose of seeing the installations there. At Leamington there was an installation, not yet, he believed, quite completed, similar to that which the committee were now proposing to establish in Bradford. Alderman Priestman went on to say that the Gas Supply Committee did not feel very anxious to prove that electricity was an article very superior to gas, because they had such a very large stake in their gas plant, but he thought that the Council might pass the resolution with confidence, and that the installation would be worth all it cost if only used to light the Town Hall, the Markets, and the Free Library. The Council had an example in the chamber that day of the effect of gas on the atmosphere, and there were many complaints of inefficient ventilation in the Town Hall. Some money had already been spent in experimenting in ventilation, and he believed it was in contemplation to spend well on to £1,000 more. If gas in the Town Hall were replaced with electric light, and the consumption of the oxygen of the air thus obviated, the building would, he thought, be found to be as well ventilated as the Council would care for. As to the Free Library, there were complaints—and all who had libraries or pictures would readily understand it—of the damaging effects of the products of the combustion of gas upon them, and he had been told by the chairman of the Free Library Committee that that committee would hail with great satisfaction the introduction of electric light. The uses to which electricity could be put were, of course, of a varied character, and not confined to lighting, and he need only mention, as a probable result of providing the installation, the introduction of additional trades into the town, such as electroplating, &c. Applications had already been made by electroplaters to come into Bradford and establish their trade there. This would, of course, be a great advantage to the town, and there was every prospect of these anticipations being realised. Where a small motive power was required he had no doubt that the electricity would be extensively used, and it was not unlikely that all the tramcars would before very long be driven by small electric engines, if the companies could obtain the power from such a source as the committee intended to provide. In conclusion, Alderman Priestman expressed the hope that he had said enough to induce the Council to comply with the very modest request of the committee, and the belief that they would have no cause to regret their action if they did so.

After a very few remarks from other members of the Council the resolution was unanimously adopted without further comment.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

16,772. J. A. MACDONALD. Birkenhead. Improvements in electric bells. December 6, 1887.

16,790. J. C. HAMBERG. London. Improvements in dynamo electric machines. December 6.

16,807. D. URQUHART. London. Improvements in or connected with incandescent electric lamps. December 6.

16,824. S. LUDWORTH and E. L. BERRY. Clapham. Improvements in apparatus for effecting the illumination of theatres and other similar buildings by fireproof means.

16,849. G. A. SCHOTH. Middlesex. Improvements in the manufacture of galvanic batteries.

16,859. C. D. ABEL. London. Improvements in electrical accumulators (C. Zipernowsky, Austria). December 7.

16,863. F. KING. London. Improvements in or connected with means of automatic electrical distribution and charge of secondary batteries. December 7.

16,870. R. TATHAM. Liverpool. Improvements in electric dynamic generators and motors. December 8, 1887.

16,8?0. A. E. COTTERELL. Birmingham. Improvements in telephonic call boxes. December 8.

16,915. J. G. STATTER. London. Improvements in electrical transformers and plates therefor. December 8.

16,926. T. FENWICK. London. Improvements in the electro-deposition of metals. December 8.

16,977. J. KENT. London. An improvement in regard to the clutch action for gripping the feed-rod in arc lamps in combination either with a solenoid or an electro-magnet working as a shunt in the main current to control the length of the arc. December 9.

17,031. W. LAHMEYER. London. Improvements in or relating to the regulation of electric currents and in apparatus therefor. December 10.

17,047. F. KING. London. Improvements in secondary batteries. December 10.

17,055. S. P. WILDING. London. Improvements in electro-magnetic combination locks for safes and vaults (C. Kintner and Herzog, United States). December 10.

17,058. S. P. WILDING. London. Improvements in electrical combination locks (C. Kintner and Herzog, United States). December 10.

17,089. M. IMMISCH. London. Improvements in the construction of the cores of the armatures of electro-motors and dynamo machines.

17,138. R. H. COURTENAY. Voltaic induction apparatus which may be applied to and combined with dynamic generators. December 13.

17,155. F. A. EDISON. Cut-out devices for incandescent electric lamps. December 13.

17,157. H. H. LAKE. Galvanic batteries. December 13.

17,209. J. WILLING. Combined switch and electric lamp supports for conveyances. December 14th.

17,231. H. EDMUNDS. Distributing electricity. December 14th.

17,232. W. GLOVER and H. EDMUNDS. Electric circuits and preventing danger due to leakage and short circuiting.

17,235. E. J. PATERSON and C. F. COOPER. Armatures for dynamo electric machines. December 14th.

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COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

December 10, 1887.

1,952. A. F. DEWAR and F. WILSON. Camberwell. An improved electric switch. February 8th.

1,993. E. HERMITE, E. J. PATERSON and C. F. COOPER. London. Apparatus for electrolysing bleaching solution. February 8th, 1887.

3,792. H. S. PETIT and H. S. BRESSON. London. An electrical fire alarm. March 12th.

December 14, 1887.

16,109. S. F. WALKER. Cardiff. Improvements in miners' electric safety lamps. December 8th, 1886.

6,853. R. W. EDDISON. London. Improvements in metal cased electric lines or cables (Tatham and Brothers, and D. Brooks, United States). May 10th, 1887.

PATENTS SEALED.

December 6, 1887.

15,094. J. H. HOLMES. Newcastle-on-Tyne. Improvements in holders or supports for incandescent electric lamps. November 20, 1886.

9,497. H. H. LAKE. London. Improvements relating to electric circuits and to switches for use in connection therewith (J. F. McElroy, United States). July 5, 1887.

December 9, 1887.

14,002. J. M. V. KENT. Westminster. A self-acting electro-magnetic combined switch and cut-out. November 1, 1886.

15,776 F. WALTON. Middlesex. Improvements in compounds for covering insulated electric and other wires, and in the treatment of the same. December 2, 1886.

15,837. J. A. KINGDON. Middlesex. Improvements in dynamo-electric machinery. December 3, 1886.

4,311. H. H. LAKE. Middlesex. Improvements in and relating to secondary batteries (A. V. Meserole, United States). March 22, 1887.

5,318. J. E. WATSON. United States. Improvements in the art of utilising electric currents in connection with electric signalling apparatus or measuring instruments. April 12, 1887.

SPECIFICATIONS PUBLISHED DURING THE MONTH.

205, 1887.—W. CHADBURN. Electrical communicating apparatus. (Price 1s. 3d.)

254, 1887.—W. CHADBURN. Electrical communicating apparatus. (Price 8d.)

12,752.—A. J. BOULT. Underground circuits of electric railway, &c., appliances.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 9th inst. amounted to £4,756.

EASTERN TELEGRAPH COMPANY.—This company announced the payment on the 14th January next (incorrectly given in our last issue as the 4th January next) of interest at the rate of 3s. per share on the preference shares of the company, less income-tax, for the quarter ending 31st December, 1887; and on the same day an interim dividend will be paid of 2s. 6d. per share in respect of profits for the quarter ended 30th September, 1887, on the ordinary shares of the company, free of income-tax. The company's register of transfers will be closed from the 6th to the 13th January, both days inclusive.

ELECTRO METAL-EXTRACTING COMPANY.—The prospectus is issued of the Extended Electro Metal-Extracting, Refining and Plating Company (Limited), the capital of which is £150,000, in £1 shares, of which 40,000 will be issued as fully-paid, in part payment for the existing patents, plant, machinery, and lease of works. The company is formed to acquire and work the business and patented electro processes for the United Kingdom of the Electro Metal-Extracting, Refining, and Plating Company (Limited), for refining, separating, and recovering tin, copper, and other metals and alloys from scrap and old metals, dross, slags, and mining tailings, and for electro-galvanising iron goods. The patents were drawn and examined by Messrs. Carpmael and Co., the patent agents, and the processes have, it is stated, been thoroughly tested and proved by actual operations during the past twelve months at the works which have been established in Hutchings-street, Millwall, while the results are such as to show beyond doubt their great value. According to the prospectus, the works have a wharf frontage to the River Thames of about 270ft., with a gridiron in the river capable of accommodating vessels up to 1,000 tons, which produces a revenue, and being near to the East and West India and Millwall Docks they possess unusual facilities for both importing and exporting goods. The lease of these premises, the machinery, and the plant are included in the purchase, so that the company are in a position to commence business immediately on completion of purchase. The prospectus states that the revenue from the London works when completed may be estimated as follows:—Profit on creating 100 tons of tin scrap per week, £277, or per annum £13,850; profit on galvanising 50 tons of iron goods per week £75, or per annum £3,750; profit on refining 50 tons of copper (exclusive of the gold and silver recovered) per week £250, or per annum £12,500; total profit £30.100. The company propose to erect and carry on four such works, in addition to the London works, and it is intended to erect them in Swansea, Birmingham, Liverpool, and Glasgow, the centres of the manufacturing districts, where the materials for the company's operations can be obtained, and the products disposed of to the greatest advantage.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended December 9th were £3,878, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

The Phosphor Bronze Company write us as follows:—It may interest your readers to know that the price of our "Vulcan Antifriction Alloy" remains unaltered, notwithstanding the great advance in price of tin, which enhances in proportion the cost of genuine Babbitt's metal.

Messrs. Bayley Brothers, of the Selborne Works, Walsall, inform us that finding their electrical business steadily increasing, they have decided to appoint Messrs. Montague J. Scott and Co., of 100, Jermyn-street, London, as their London representatives.

Messrs. Hull and Stewart, after being employed as engineers by Messrs. Woodhouse and Rawson for many years, have gone into partnership as electric light engineers and contractors, with offices at Newark-on-Trent.

NEW COMPANIES REGISTERED.

THE PORTLAND ELECTRIC LIGHT COMPANY (LIMITED).—Registered by Robinson and Turnbull, 4, Mitre-court-chambers, E.C., with a capital of £45,000, in 9,000 shares of £5 each. Object: To enter into contracts for electric lighting with any corporation or person, and to supply all machinery, motors, generators, lamps, materials, or appliances in connection with the business of the company.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Dec. 14.		Business Done Week Ending Dec. 14. Highest.	Lowest.
Anglo-American	87,	88	88	87½
Do. Preferred	61½,	62½	62	60¾
Do. Deferred	13,	14	13¾	13¼
Brazilian Submarine	12,	12½	12¾	11¾
Cuba	11¾,	12¼	12¼	—
Do. Preference	18,	19	18½	—
Direct Spanish	3½,	4	4	3 13-16
Do. Preference	8,	9	—	—
Direct United States Cable	8⅝,	8⅞	8¾	8⅝
Eastern Telegraph	11⅛,	11⅝	11⅝	11⅛
Do. 6 per Cent. Preference	14¼,	14¾	14½	14¼
Do. 5 per Cent. Debentures, 1899	106,	109	107½	107
Eastern Extension	12⅛,	12⅜	12 5-16	12
German Union	9¼,	9¾	—	—
Globe Telegraph and Trust	5⅜,	5⅝	5 9-16	5⅝
Do. Preference	13⅛,	13⅝	13⅜	13⅛
Great Northern	13½,	14	13⅞	—
Indo-European	37,	39	37¾	37
London Platino Brazilian	4,	4½	4⅝	4½
Reuter's	8,	8½	—	—
Submarine	125,	135	—	—
West Coast of America	4½	4¾	—	—
Do. Debentures	110	114	—	—
*West India and Panama	1,	1¼	1¼	1 1-16
Do. 1st Preference	9¾,	10¼	9 15-16	—
Western Brazilian	8¼,	8¾	8¾	8⅜
Western Union 7 per Cent. 1st Mortgage	117,	123	—	—
Do. 6 per Cent. Sterling Bonds	101,	104	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	9-16,	11-16	⅝	—
Oriental	½,	⅝	—	—
†United Telephone	11¾,	12¼	12	11⅝
United River Plate Telephone	4¾,	5¼	—	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	2,	2½	2¼	2
Do. (fully paid)	2½,	3½	—	—
Swan	1¼,	1½	—	—
Maxim Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	38,	39	38⅜	38
India Rubber, Gutta Percha and Telegraph Works	21,	22	21⅜	21

* xd. 9s. on account of arrears of dividend. † xd.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 501.—Vol. XX. FRIDAY, DECEMBER 23, 1887. Price 4d.

NOTES.

An output of 25 watts per lb. of dead weight is by far the best performance for a dynamo—in this particular—that we, at present, remember to have come across. This, however, is the figure claimed by Messrs. Paris and Scott for a small machine running at 1,000 revolutions, of which some particulars will be found at the end of an article further on. Of course, we shall not be at all surprised if the above remark leads to our being further instructed in this matter—a result which we should hail with satisfaction.

It would, for instance, be interesting to know how the turbo-dynamos of Messrs. Clarke, Chapman, Parsons and Co. compare in this respect, the weight of the dynamo alone being taken into consideration.

We happen to remember that some months ago a certain electrical engineer (a man, by-the-bye, of no slight eminence in his profession), confided to us that he was sometimes animated by a secret desire to build constant potential dynamos with cast-iron field-magnets, "and would, in fact, have done so long ago but for the look of the thing." So, now that the example has been set elsewhere, we shall expect ere long to learn that our esteemed friend and excellent neighbour has at length found the courage of his convictions.

Cast-iron magnets for incandescent dynamos having recently been successfully introduced, it only remains for some one else to build a machine—as we believe Mr. Kapp once threatened to do—with a single horseshoe magnet turned upside turned down, with its pole-pieces bolted to the cast-iron bed-plate. Magnetism is cheap. This reflection should afford some consolation to the makers of dynamos when copper is dear.

If this should meet the eye of Mr. B. E. Sunny, of Chicago, we would invite him to consider the meaning of the word "banter." In America, as in England, it may be sometimes called chaff; but with us it can rarely be mistaken for a sneer. We have never sneered at Mr. Sunny, and, what is of more consequence, never at "American achievements." The editor of the *Western Electrician*, where Mr. Sunny accuses us of these offences, confesses that the facts as presented at the time in Mr. Sunny's paper on underground wires were liable to be misunderstood. This was precisely our opinion; and in commenting on the paper we playfully pointed out where the misunderstanding would come in. That we were not able to export at the same time the requisite sense of humour for understanding us is to be regretted; but it is an explosive commodity that will not bear transmission through the post.

Our readers will scarcely fail to be struck with the extreme beauty and ingenuity of the electrometer fault-resistance test employed by Mr. Arthur Wright at Brighton, and which is described in another column. The electrometer designed for the purpose is also wonderfully simple and accurate, and, like all his special apparatus, was made by Mr. Wright himself.

Next to the unique and successful character of the operations carried on at Brighton, perhaps the most striking point is the simplicity and effectiveness of the means employed. For instance, the "empirical loop test," or, as it might be called for the sake of the alliteration, the "lineman's loop test," is almost comically simple in application. It is evident that, notwithstanding the admirable work already done (in particular by Mr. Kempe), we have not yet exhausted either the requirements or the possibilities of the situation in adapting refined methods of testing to the work of heavy electrical engineering.

We shall next week give some information as to the cost of supplying electricity at Brighton, particularly with regard to the relative distribution of the various charges which go to make up the total. The figures will be found to be of a very instructive character, and, so far as they can be generalised from, they tend perhaps to upset some of the ideas most commonly held in this country as to central station lighting.

We quote the *Brighton Herald*:—"For the first time in its history, strange and eventful though it has been, the Royal Pavilion at Brighton was the scene on Thursday of a brilliant entertainment in honour of one of the native Princes of India. The event might justify a disquisition more or less to the purpose respecting the chain of historical circumstances that has led to so unique an incident, for, to compare small things with great"—but hold! it may be this article is copyright; let us therefore judiciously skip a column or so. And now, good friends, read this:—

"The entertainment was, in short, complete in every respect, even down to the presence of a staff of detectives and of Police Firemen (under Mr. T. Gibbs), who, *as the electric light was used* in all the principal rooms, were held to be necessary."

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Our contemporary omits, perhaps, to mention that, the town water having recently been laid on, a staff of the Royal Humane Society were present (under Mr. T. Noodle), in case the water-pipes should burst.

ACCORDING to a writer in the *Boston* (U.S.) *Herald*, the telegraphs in Mexico afford abundant exercise and recreation to the monkeys which abound in the wooded districts of that country. As many as a hundred able-bodied members of the tribe may often be seen looped together, swinging in festoons from the wires, or performing acrobatic feats, which frequently end in bringing the gymnasium to earth, and utterly breaking down the telegraphs. Here would be a chance for Mr. Caws and his spring shackles.

THE new electrical type-writing instrument invented by Mr. Higgins (of the Exchange Telegraph Company) is one of the most beautiful (if superlatives are permissible in a technical journal we might almost be inclined to say *the* most beautiful) and certainly one of the most ingenious adaptations of electrical and mechanical science which has ever come under our notice. The first set of apparatus of this description has quite recently been completed, and the engraving in the text was taken from this instrument, which Mr. Higgins has been good enough to send for our inspection. The mechanical action (when actuating the armatures by hand) appears to be quite perfect in every particular, and although we have not as yet had an opportunity of testing its performance when driven by a battery, the result is not open to further question. The most remarkable part of the design lies in its entire freedom from intricate and delicate mechanism; the whole of the moving parts are readily accessible, and the adjustments are of a simple and obvious character. The convenience of an instrument of this description, which prints on letter paper like an ordinary type writer, will be fully appreciated.

Is it possible that the manufacture of electric bells and accessories, of however "improved" a type, can find profitable employment for a capital of £100,000? Considering the number of manufacturers already in the field we take leave to doubt it. Can a series of patents for electric bells and accessories be worth £30,000, one-half in cash down? We doubt this still more.

A CORRESPONDENT, signing himself "A Poor Victim," writes to us from Newcastle complaining that he has been done out of three guineas by a medical electrician, who sold him an electropathic belt which proved to have not a trace of electricity in it; and he asks us to expose the imposture. We should like to oblige our informant, and still better to warn the public generally against this species of quackery. But in the first place we are not sure that the belt was any the worse for not being electrical, or that it would have been any the better for being what it professed to be. An "electric belt" has, perhaps, a trifle better *raison d'être* than a "magnetic" belt. But in the present state of electro-medical science it is at least certain that the indiscriminate use of such appliances can do little or no good and probably little harm save to the pockets of too credulous victims. When a "cure" is effected by such means we take it that the elements of success consist (in various proportions) of fortuity, faith, and flannel. The second of these is doubtless often a potent factor, while the third is perhaps the most trustworthy. Our correspondent has our sympathy, but a blind reliance in advertising quackery is scarcely calculated to win our esteem.

Telephones in the United States.—The number of telephones in use in the United States is at present estimated at 175,000.

Midhurst (Sussex).—The "Lighting Inspectors" of Midhurst, Sussex, are open to receive tenders for lighting the streets of that town "by oil, gas, or otherwise."

French Cables in the West Indies.—A cable is about to be laid for the Société Française des Télégraphes Sous-Marins, connecting Cuba with Venezuela, Curaçoa, St. Domingo and Hayti.

Ramsgate.—We understand that Mr. R. Coveney, of Ramsgate, is preparing plans for a central lighting station in the town, a large number of customers having been already secured.

Train Lighting in Russia.—The South-Eastern Company of Russia have adopted the electric light on their trains, not only in the carriages, but the usual engine lanterns are replaced by two powerful arc lamps.

Boiler Explosion.—On Friday last a boiler explosion at Westchester, near Philadelphia, destroyed the electric light plant, and left the town in darkness. Six persons were killed and six injured by the explosion.

Exeter.—Preparations for the introduction of the Thomson-Houston system are being actively pursued in Exeter. The fixing of the poles and wires in High-street, Queen-street, and a portion of St. Sidwell's is nearly completed.

Lighting of Corn Mills at Bacup.—In reference to the Note on this matter in our issue of December 9th, Mr. H. Bury, of Manchester, who carried out the work, asks us to correct the name, which was erroneously given as Mr. W. Bury.

Lamp Factory.—We learn from a French contemporary that Messrs. Woodhouse and Rawson are about to build an incandescent lamp factory at St. Nicholas d'Airlemont, in the Department of Seine-Inférieure. It is said that the whole of the staff will be of French nationality.

Leeds.—At a joint meeting of the Leeds Corporation Electric Lighting and Fine Art Gallery Committees on Monday the question of the lighting of the new art gallery was considered, and it was ultimately decided to employ incandescent lamps for lighting the whole building.

Glasgow.—The Bazaar Committee of the Glasgow Town Council has agreed to recommend the acceptance of the tender of Mr. Richard Miller, 54, St. Enoch-square, for the electric lighting of the Corporation Bazaar and City Hall, amounting to £1,448. 7s. 6d. The Thomson-Houston system will be employed.

Cheltenham.—The local journals of this town have lately contained a discussion on the *pros* and *cons* of the question of introducing electric street lighting. So far the *cons* appear to have it; but for a wealthy and fashionable town like Cheltenham, doubtless the introduction of both arc and incandescent light is only a question of time.

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Telephonic Communication between Paris and Lille.—There are now five long-distance telephone lines from Paris, the latest addition being a line to Lille, which was opened for use a few days since. The other four lines run to Havre, Rouen, Rheims, and Brussels. The users of these lines are instructed to speak "slowly, distinctly, and in a high-pitched voice."

Installation Work.—Messrs. Woodhouse and Rawson have recently carried out the following installations :—At Messrs. Crosse and Blackwell's ; Messrs. J. J. Murphy and Co., Cork ; at Lord Brassey's residence, Park-lane, the museum containing curiosities collected by the late Lady Brassey ; also a temporary installation for the Alpine Club at Willis's Rooms.

Improvement in Continental Telegraph Service. — The *Diario Popular*, of Lisbon, states that the international telegraph service over the land lines has lately shown a very great improvement both in clearness and rapidity, messages from Versailles having been received in Lisbon with a delay of fifteen minutes only. The improvement is attributed to the use of the Hughes apparatus.

"Scientific News."—We are informed that *Scientific News for General Readers*, which has hitherto been published monthly, will, owing to its increasing popularity, be published weekly from the first week in January next. This journal "seeks to explain in untechnical language useful and interesting applications of science, and to make its readers acquainted with the scientific events and discoveries of the day."

Trade Catalogue.—We have received a copy of the third edition of the illustrated price list and catalogue of electric lighting apparatus and material issued by the Electrical Apparatus Company, of 4, Charing-cross. The pamphlet contains a very complete list of electric light apparatus and fittings of all kinds ; some of the electroliers and coloured glass shades are of particularly handsome and effective design.

The "Dynametroscope."—A contemporary journal, *Invention*, contains an account of a new instrument called a "dynametroscope," by means of which we learn that "with a given electromotive force and current the candle-power of any dynamo may be read off, and the laborious calculations hitherto necessary for the attainment of such results entirely avoided." The construction of the apparatus is not explained.

The Atlantic Cables.—The *Central News* says :—"The cable between Germany and Valentia, by which a portion of the Continental traffic for America is sent to the United States *viâ* the Anglo-American lines, has been interrupted during the past few days. It is believed the cable has parted somewhere off Hastings. A special staff has been sent from the Telegraph Construction and Maintenance Works to repair the fault if possible.

"A Little Parable."—A correspondent writes us as follows : "It appears to me that the Fire Risks Committee of the S. T. E. is like unto a certain fox, which was called Brer, of whom it is written 'Brer Fox, he lay low and said nuffin, all winter ; an when May come Brer Fox he find sayin nuffin berry hard work, so he done take holiday till next winter. Den Brer Fox he lay low again an kep on sayin nuffin' (till *next* May ?)."

"Electrical Plant."—We are pleased to note the continued success of the monthly trade catalogue published by Messrs. Wheatley Kirk, Price and Goulty. In addition to the advertisements of new and second-hand plant some editorial matter has recently been introduced which will tend to increase the value of the publication. The publishers write to us to the effect that subsequent issues will appear on the 1st instead of on the 15th of the month, as heretofore.

Submarine Illumination for the Torpedo Service.—Experiments have recently been made in the United States Navy on the employment of submarine incandescent lamps by torpedo boats. The plan adopted is to mount a 100 candle-power lamp at the end of a submerged pole 20ft. in length, which is lowered vertically from the side of the vessel. By this means the water is illuminated to a radius of 150ft., though the light is not visible from a distance.

Derry Electric Lighting Scheme.—A few days since the Derry Corporation had under consideration several contracts for the lighting of the city by electricity. After some investigation and discussion it was decided to instruct their solicitor to put before counsel the relations subsisting between the Corporation and the Gas Light Company, and have a legal opinion on the powers of the Corporation to enter into the proposed scheme. The question is causing a good deal of interest locally.

Telephones in Hospitals.—The Equitable Telephone Association have received an order to fit up eleven of their A type "Swinton" telephones in the Hospital for Consumptives, Ventnor, Isle of Wight, for the purpose of communication between the different wards, the resident doctor, the porter's lodge, &c. The instruments will be connected to a central exchange, so that they can all be switched into communication one with another. It is expected that this installation will, when completed, save the hospital authorities much time and trouble.

Telephonic Communication with Ships at Anchor.—It is stated that the Compagnie Transatlantique, whose vessels sail from Havre, are about to establish telephonic communication with their ships while lying at anchor in the roadstead by means of a cable attached to the buoy to which they are moored. Considering the difficulties encountered by the Telegraph Construction and Maintenance Company and the enormous expense incurred in maintaining communication between the shore and the lightship of Walton-on-the-Naze, we are rather inclined to doubt whether this will be found a practicable scheme, even in a sheltered roadstead.

The Royal Institution.—The following are the lecture arrangements at this Institution up to Easter, 1888 :—Sir Robert S. Ball, six lectures (adapted to a juvenile auditory), on "Astronomy : The Sun, Moon, Planets, Comets, and Stars," commencing on the 27th inst. ; Mr. G. J. Romanes, 10 lectures, "Before and After Darwin ;" Mr. Hubert Herkomer, three lectures, on "The Walker School," "My Visits to America," and "Art Education ;" Mr. C. Hubert H. Parry, four lectures, on "Early Secular Choral Music ;" the Rev. W. H. Dallinger, three lectures, on Microscopical Work, with Recent Lenses on the Least and Simplest Forms of Life ;" Lord Rayleigh, seven lectures, on "Experimental Optics ;" and Mr. William Archer, on "The Modern Drama : French, Scandinavian, and English."

Telephone Communication between Brighton, Lewes, and Shoreham.—The South of England Telephone Company announce that they have established telephone exchanges in Lewes and Shoreham, and that they are now in direct communication with the Brighton exchange system. The use of the trunk lines for inter-town communication is free of extra charge to subscribers, from their own instruments only. Public call rooms are established from which communication with any of the towns connected may be held on payment of sixpence. Up to the present ten public call rooms have been established, of which there are six in Brighton, three in Lewes, and one in Shoreham. Trunk line connections are also in

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process of erection with Eastbourne and Worthing, and the company hope early in the ensuing year (1888) to announce their completion.

The Paris Exhibition, 1889.—The Commission of Control and Finance of the 1889 Exhibition have decided that the Exhibition should be open in the evening, and lighted with the electric light. The entrance fee in the evening will be two francs, of which one franc is to be paid to the electric light companies that will illuminate the buildings and grounds. These companies will continue to receive half the entrance money paid in the evening till the total thus received amounts to two million francs, after which the State will share in the profits. This arrangement, which was adopted by seventeen votes against eight, was hotly opposed by M. Christophle, in the name of the Society of Guarantee; and on the proposal of M. Dautresme, Minister of Commerce and Industry, it was decided that a special commission should investigate the contracts to be made with the various electric lighting companies.

The Gime Carbons.—In all cases where a strong green tint is not objected to in an arc light, it appears that carbons manufactured by a new process due to M. Gimé possess great advantages. Not only are they consumed much less rapidly, but we learn that with carbons of equal size, and with the same current, nearly three times as much light is produced by the Gimé carbons as by the ordinary forms. For this reason they are about to be tried by the French Government for lighthouse purposes. The green tint is due to the presence of boron. The process of manufacture is as follows:—A very pure form of coke is reduced to a fine powder and mixed with a hydro-carbon (*houille-maigre*). To this is added a saturated solution of boric acid at a temperature of 50deg. C. The plastic mass thus obtained is moulded under pressure, and raised to a red heat in a furnace. The processes are thus very simple, and the carbons are said to be made at a very economical rate.

Use of the Telephone on Railways.—Far more extensive use is made of the telephone on the railways of the Continent than in this country. In Germany in particular an extensive series of trials have been carried out with this instrument on the State lines, and the Government has just issued a memorandum to the railway companies embodying the results of their experience. From this it appears that for local and branch lines, where the traffic is small, the telephone has in many cases entirely displaced the telegraph; and of late it has been considered safe to extend the system to busier lines where the telegraph was at one time considered indispensable. In these instances, however, we take it that the example of Germany is not at all likely to be followed in this country. But for intercommunication amongst the different departments of the larger stations the telephone is in almost universal use, and it is stated that no insuperable difficulty is experienced owing to the induction from other wires. All long-distance trains also carry telephone apparatus to be attached to the telegraph wire in the event of a breakdown *en route*. This is an example which it certainly might be useful to imitate.

The Electric Lighting of the City.—On Tuesday last a meeting of the City Commission of Sewers was held at Guildhall, Mr. Graham King presiding. A report was brought up by Mr. J. C. Bell from the Streets Committee submitting for adoption a proposed arrangement with the Anglo-American-Brush Electric Light Corporation for lighting a district of the City. It stated that the area proposed to be lighted was that comprised between the Royal Exchange, Poultry, Cheapside, St. Paul's-churchyard, Ludgate-hill, and Fleet-street, on the north, and Queen Victoria-street and the Thames Embankment on the south. The arrangement contemplated the furnishing of 169 arc lamps of 2,000 candle power at a cost of £26 per annum each, in place of 616 gas lamps, or in the narrow parts glow-lamps or arc lamps of less capacity and greater number might be substituted at an additional cost of 50 and 25 per cent. respectively. The contract would be for a term of seven years certain, with power to renew for a further term of seven years, provided the Commission did not grant to other companies powers with regard to private lighting. At the instance of Mr. Parnell, the consideration of the report was adjourned.

Transmission of Power in Madrid.—The Madrid paper *El Economista* gives some particulars of a movement now under discussion in the Spanish capital for the formation of a joint stock company for the purpose of supplying electric light and motive power by power derived from the River Manzanaras. It is proposed to divert 2,000 litres of water per second from the river, so as obtain an effective force of 2,700 horse-power. Conveying this force by electricity, and converting it into mechanical motion, it is estimated that the available power will be reduced to one half, namely 1·350 horse-power. It is proposed to supply power for ten hours daily, and to accumulate the supply of water at the rate mentioned above during the fourteen hours when the machinery would not be working. The *Economista* enters into a calculation to show the financial success awaiting such a scheme should it be carried out, and sums up by stating that the advantages which would accrue to the industries of Madrid would be unquestionable. Instead of paying 50 centimos de peseta (about 5d.) per hour, which it states is the cost per horse-power of gas engines, the user of the new power would only have to pay 25 centimos, say, 2½d. per hour; while, in the case of lighting, taking the cost of gas at 5 centimos per light per hour, the electric light of equal brilliancy would cost 2½ centimos only.

An Automatic Potential Recorder.—We learn from *Industries* that "Herr Zacharias, of Berlin, has introduced an apparatus for automatically recording the pressure in the mains of an electrical supply system which is in use here with very satisfactory results. The apparatus, which has been made by Messrs. Siemens and Halske, consists of an ordinary clock with a pendulum making eighty beats per minute, and which closes every forty-five seconds an electric contact, throwing an electro-magnet into circuit. The armature of this magnet is balanced by a spring, so as to occupy a definite position when the standard pressure of 120 volts is in the mains. If the pressure is either greater or smaller the armature occupies positions to either side of the normal. The armature is provided with a pin, in front of which slowly revolves a cylinder carrying a paper strip, with a line marking the position which corresponds to 120 volts. At the moment of making contact with the electro-magnet the current is also sent through another electro-magnet, which presses the cylinder for an instant against the pin on the armature of the first magnet, and thus a hole is pricked, and the position of it on either side of the 120-volt line shows the variation of pressure existing at the moment. After a few seconds the current is again interrupted, and the same cycle of operation is repeated every forty-five seconds; thus a series of marks is obtained on the paper strip, forming a record. Herr Zacharias also tried to obtain an absolutely constant record by keeping the paper strip always up to the pin; but this not proving successful, the plan of recording at short intervals was adopted."

Dublin.—At a recent meeting of the Dublin Town Council a resolution to proceed with the scheme for lighting a certain

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portion of the town with arc lamps was brought up and confirmed. It was incidentally mentioned that the amount of the highest tender received was in very close accordance with the estimate of the city engineer, but the sum was not named. In reference to the early history of electric lighting in Dublin Mr. Councillor Mayne told the following pathetic story:—The reason why money was lost in connection with the Electric Lighting Company in Dublin was that they were not only the first *bonâ fide* commercial electric lighting company started in the three kingdoms, but he believed they were the only one. They had to learn all their business and had to work with the only class of engine—the semi-portable one—which was at the disposal of the electric lighting companies at that date. They had consequently to spend more upon coal for the working of their concerns by nearly ten times as they would have had if they had the improved engines. Even with all that disadvantage they had just turned the corner, and they had succeeded in making just as much profit in winter as compensated for any want of profit in the summer, and they had just arrived at a stage when the use of a little more capital spent on additional plant would have enabled them to earn so much profit that they could have given their shareholders a dividend. But just then the electric lighting panic set in, and their shareholders, forgetting that they were shareholders in a *bonâ fide* commercial concern, put themselves in the same boat with the shareholders of bogus companies, who were losing, and deserved to lose, the investments they had made The shareholders got nervous, and in obedience to their fears the company was wound up. No sooner was the company out of existence than the gas company bought the plant cheaply and charged considerably more than the electric lighting company were charging, and making a profit out of it. He would be very much surprised if the corporation, with the advantages they had, were not able to light the city very much better, and at a less cost than the gas company did.—The resolution was carried.

The Lighting of Weston-super-Mare.—At the last meeting of the Weston-super-Mare Town Commissioners the Lighting Committee, of which Mr. Heap is chairman, presented an interim report as to their action with regard to the lighting of the town after the present contract with the gas company expires. On November 14th they directed the clerk to ask the gas company a series of questions in reference to the terms upon which they would supply the Board with their commodity at the termination of existing arrangements, and to specify what would be their prices for illuminating the town with gas to the present extent, to an increased extent so far as regarded the esplanade, or with the exception altogether of the Sea Front, &c. The committee met again on the 24th ult., and were joined by Mr. Massingham, managing director of the Taunton Electric Lighting Company, who informed them that the greater number of electric lights used the less per light would be the charge; that sixty lights would be a good number to have, as they would just employ two dynamos; that each light would give 1,200 candle-power; that the lights should be placed 100 yards apart; that should sixty lights be used for six hours per night they would cost £18 per light per annum; that Taunton was paying at the rate of £22. 10s. per light per annum; and that on sixty lights being adopted they would entail, according to his (Mr. Massingham's) estimate, 1d. in the £ extra on the general district rate for the year. The committee, accompanied by Mr. Massingham, then proceeded to the Sea Front and other parts of the town to view and select sites for lamps in the event of the electric light being adopted and the plant fixed. Twenty-three sites they apportioned the Sea Front, and the remainder they distributed over the principal thoroughfares of the town. Again on the 28th ult., and again on December 5th, the committee met, and decided that, in case the electric light were adopted, sixty lights would be required for the illumination of the town. They also determined to advertise for information and tenders in regard to the provision of the electric illuminant, determining as the latest time at which tenders should be sent in the 19th of the present month. On the 12th inst. the committee had the replies of the gas company to hand, but regretted to ascertain that their question in respect of the gas lighting of the town apart from the Sea Front had not been answered. They instructed the clerk to make further inquries of the company, and to elicit the company's terms for long contracts. They were now awaiting a further communication from the gas company.

Indian Government Telegraph Department.—By the recent reorganisation of the Indian Government Telegraph Department the grades and emoluments of the higher or gazetted appointments have been very materially improved, and the service now stands second to none in respect of position, pay, and pension. In consequence, however, of the block in the service, which it is the object of the new rules to remove, the service staff is complete, and only two appointments to the grade of assistant-superintendent are at present made every alternate year, candidates being prepared at and passing through the Royal Indian College of Engineering, Cooper's Hill, Staines. The staff now sanctioned is as follows:—One director general, Rs.3,000 per mensem; one deputy director general, Rs.2,000 per mensem; two directors (construction and traffic), Rs.1,600 per mensem. The superintendents will be divided into three grades—four first grade, on Rs.1,125, rising to Rs.1,500; nine second grade, Rs.1,000 to Rs.1,500; sixteen third grade, Rs.850. *Assistant superintendents* will be divided into two classes of two grades each, twenty in first grade (first class) on Rs.700, and twenty in second grade on Rs.550; sixteen in first grade (second class) on Rs.400, and sixteen in second grade on Rs.300. The *strength* of the *superior establishment* will ultimately be fixed at eighty-four. *Personal allowances* will be given on the following scale for meritorious service:—Assistant superintendents, first class, first grade, Rs.100 after 22 years' service, and second grade Rs.100 after 17 years; first grade, second class, Rs.100 after 12 years, and second grade Rs.50 after 7 years. Officiating promotions will in future be from class to class, not from grade to grade. The following new pension rules for the superior establishments are sanctioned:—All officers who have served 18 years, of which not less than 16 have been on active service, are eligible for retirement. Pensions will be granted on the following scale to those whose resignations may be accepted:—(*a*) The pension which would be due, under the existing rules, of officers concerned retired on medical certificate; (*b*) Additional pension calculated on the following scale: to officers under 50 years of age, Rs.1,000 per annum; officers in their 51st year, Rs.900; officers in their 52nd year, Rs.800; officers in their 53rd year, Rs.500, provided such resignations are submitted before March, 1888. Officers who have completed their 53rd year will receive no extra pension, but may retire under the provisions of clause (*a*). Similarly, all officers who attain 16 years' active service on any date subsequent to October, 1887, are eligible to retire on the above terms, provided their resignations are received by the Government within six months of the day on which they attain the necessary qualification.

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SOME ENGLISH CENTRAL LIGHTING STATIONS.

I.—BRIGHTON.

(Continued from page 128.)

The Mains.

The total length of the mains is at present about fifteen miles, the farthest point reached being about three miles distant from the station. The conductors are carried overhead, and consist of No. 7 B.W.G. bare copper wire. So carefully have they been erected, that up to the present time the company *has never had a broken span*. The total average loss by energy absorbed in the mains amounts to 5 per cent. This is known by comparison of the number of volt-hours paid for by the consumers, with the number registered by the meters which are connected with the terminals of the circuit. It has been determined in all further extensions of the system to employ fluid insulators (Johnson and Phillips), and a considerable number have already been put in.

Insulation Resistance of Mains.

A test for insulation is taken twice every day on each circuit. Practical experience proves the absolute necessity of this precaution when employing a high-tension system. It is, moreover, very necessary to be able to distinguish between a general leakage more or less equally distributed over the whole system, the amount of which is of course largely dependent on atmospheric conditions, and (on the other hand) a fair degree of insulation on the whole accompanied by a fault, or incipient fault, of comparatively low resistance. For instance, an insulation resistance on a wet night of 10,000ω per mile if equally distributed, though lower than desirable, is not found to be a dangerously low figure; but an insulation resistance showing a resultant fault of the same value, but which meant megohms on the greater part of the line and a 10,000ω resistance at one particular spot, would be a highly dangerous condition.

Empirical Loop Test for Position of Fault.

When the current is *not* on, the determination of the position of a fault presents no difficulty. The position and average

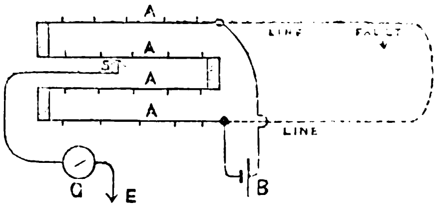

Fig. 11.

value of the resultant fault when the line is in proper condition is carefully recorded from time to time, and this value is so high that if any serious leakage occurs at any other point on the line it practically cancels the normal resultant fault, so that an ordinary loop test will indicate the position of the new fault with a degree of accuracy which as a rule leads to the speedy detection of the exact spot. The method of applying the test has been reduced to so simple a form that the ordinary lineman can carry it out. This simplicity is attained by the graduation of the slide-wire bridge in terms of the corresponding lengths of the line itself. This will be easily understood from the diagram, Fig. 11. A A A A represent four lengths of German silver wire, connected by copper strips at alternate ends, and mounted vertically upon a screen. Close at hand is a mirror galvanometer, G, the terminal of which is connected to earth, and the other to a slider, S, which makes contact with the German silver wire. A battery, B, is joined up across the terminals of the slide resistance wire, and the line to be tested is connected as a shunt to the battery, so that we have the conditions of the ordinary loop test. The empirical graduation of the scale is effected for each line separately when first installed or altered. For this purpose a lineman is sent round the circuit who makes dead earth at each installation successively. When earth is made at the first house a balance is obtained on the bridge, and an arbitrary reference number is marked upon the corresponding position of the scale. This number is entered in a book opposite the name and address of the consumer in question. The lineman then proceeds to the next house and so on. It may be mentioned that communication is maintained between the lineman and the station through a telephone which is temporarily connected with the line. When a new installation is put in its "bridge number" is taken in the same way. For the actual test it is therefore only necessary to obtain a balance, and then on referring to the list the lineman is at once directed to the spot where the fault will probably be found.

Before applying this test it is, however, necessary to ascertain that there are no lamps in circuit, otherwise the results would obviously be inaccurate. For this purpose it is only necessary to take the "copper" resistance of the line. This is usually done with a differential galvanometer, and as the true resistance of the line itself is known it is not needful to measure the actual resistance of the circuit, but only to see whether or not a balance is obtained with the normal adjustment.

Insulation Resistance (*continued*).

After some experience Mr. Wright came to the conclusion that the measured value of the insulation resistance while the line was not in use gave very little idea of the true insulation resistance with a P. D. of 2,000 volts at the terminals of the circuit. It was sometimes found that the insulation tested very high with the battery, but yet gave manifest signs of imperfection under the E.M.F. of the machine. It therefore became necessary to devise means for measuring the actual resistance of a fault (or the resultant fault), and to do this while the current was on. For this purpose Mr. Wright devised an extremely ingenious electrometer test which we will now describe. We may premise that a special and very practicable form of electrometer is employed, which we shall describe later.

Electrometer Test for Resistance of Fault While Current is On.

The method of carrying out this test is as follows:—(1) The positive pole of the dynamo which is supplying the circuit to be tested is connected to one terminal of the electrometer

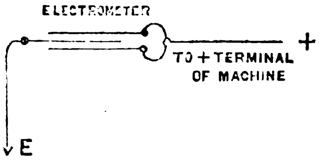

Fig. 12.

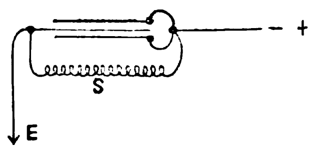

Fig. 13.

(there are no "quadrants" in the instrument employed), and the other terminal is connected to earth. The deflection obtained is proportional to the fall in volts from the positive pole up to the fault*—call this p. The connections are shown in Fig. 12. (2) The positive pole of the machine is next connected to earth through a high resistance shunt s, and the P. D. between this pole and earth is again measured, which is, of course, less than before. Call this q. Then if x be the resistance of the fault it can be shown that

$$x = s\,\frac{p-q}{q}.$$

The connections are shown in Fig. 13.

The proof is as follows:—

In Fig. 14 let A B represent the resistance of the line, A being connected with the + and B with the − terminal of the dynamo:

* In order to make this point perfectly clear it may be as well to point out that in the theory of the test it is assumed that the resistance of the remaining resultant fault is very great in comparison with that of the fault which is being tested for. This is also the usual condition of practice. But the resultant and the actual fault may be considered to stand in series connection in the earth circuit. Hence the current through the fault during the first part of the test is negligible, and the electrometer may be considered to be joined up directly to the conductor at the point in question.

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and let A E be the difference of potential at the terminals. Then the slope of potential is represented by E B. Let there be a fault at F, then the fall of potential up to the fault is represented by E K; call this p.

Now let the + pole be connected to earth through a shunt, s, whose resistance is represented by K L, thus forming a new circuit, whose resistance is made up of that of the line up to F, the fault itself, and the wire s, which is usually about 100,000ω. The resistance of the line is, of course, negligible in this combination. Let x be the resistance of the fault. Then the slope of potential in this circuit is represented by the line E M N.

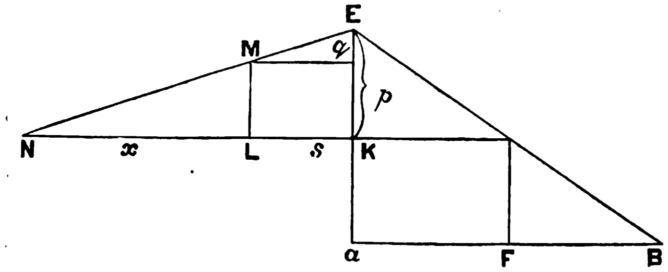

Fig. 14.

The electrometer being connected as before, a reduced deflection is now obtained which represents the fall of potential over the shunt s, and is therefore equal to E H, or q. But the current in the shunt is the same as that through the fault resistance x, and we have therefore, by similar triangles,

$$\frac{p}{x+s}=\frac{q}{s},$$

$$\text{or } x=s\frac{p-q}{q}. \qquad \text{Q.E.D.}$$

A still more simple proof may be obtained alegebraically; but the physical conditions of the test are not so clearly brought out. The algebraical proof is obtained at once by writing

$$\frac{p}{q}=\frac{x}{\frac{xs}{x+s}},$$

from which $x=\frac{s\,(p-q)}{q}$ as before.

THE BRIGHTON ELECTROMETER.

Mr. Wright's electrometer (Fig. 15) is a gravity instrument; it is excessively simple in construction, and well adapted for

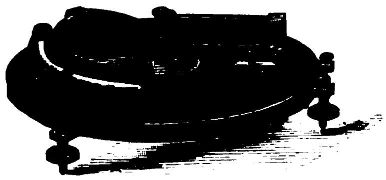

Fig. 15.

use under the practical conditions of an electric lighting station. Its reliability has been fully demonstrated by the excellent service it has rendered at Brighton. It consists of two curved plates of metal, somewhat of the shape of the longitudinal section of a kidney bean, set one over the other with a suitable space between, and inclined to each other in such a way that they are nearest together at the narrower ends. The two plates being fixed in this relative position are then slightly tilted from the horizontal, so that the narrower ends are raised a little higher from the ebonite base. Between the plates, which are in metallic connection, is placed a movable tongue or armature supported on an axis, which is slightly inclined to the horizontal in such a way that when the needle is deflected it retains its central position between the inclined plates in all positions. The tongue carries a pointer which moves over a scale on the front of the instrument, and it has also a projecting arm carrying a small weight. The zero mark on the scale is towards the lower and more widely separated ends of the plates; the needle is balanced in this position, but, owing to the tilt, when the needle moves into any other position the weight is raised against the force of gravity.

The action will now be easily understood.

The points whose P.D. is to be measured are connected one to the needle and the other to the metallic plates. The static charge then tends to deflect the needle against the force of gravity, as just explained. By means of careful experiment Mr. Wright has succeeded in adjusting the shape and position of the various parts so as to obtain a proportionate scale. There is evidently a wide field for an instrument of this class, which is, of course, as well adapted for alternating as for continuous currents.

(To be continued.)

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY A. E. KENNELLY.

CHAPTER IV.—*Resistance (continued).*

(Continued from page 130.)

39. Since the resistances which are dealt with in telegraphy may sometimes be exceedingly small—perhaps that, for instance, of a short length of thick copper wire offering a minute fraction of an ohm—and on the other hand may be very great, such as that of the insulating gutta percha covering of a short length of cable core amounting, it may be, to billions of ohms, it is convenient to adopt two secondary units, one a multiple and the other a sub-multiple of the ohm. Thus a million ohms is spoken of as a megohm, and is usually represented for brevity by the last capital letter, omega, of the Greek alphabet (Ω)—thus 227·5Ω means 227,500,000 ohms. The ohm itself is commonly represented by the small letter omega (ω). One-millionth of an ohm is called a microhm, and has at present no representative symbol. Thus, 7,560 microhms is the same as 0·00756ω.

40. Resistances that are connected in series or simple circuit are always directly additive. This is obvious from the fact that any resistance may be regarded as an equivalent length of some particular wire, and we have seen that the resistance of a wire is proportional to its length. Thus, if a circuit be composed of a battery of 40ω total internal resistance, an overhead conducting wire of 50ω, and the copper wire wound on the coils of a sounder of 35ω, then we may regard that circuit as being equivalent to 135 miles of wire whose resistance is 1 ohm per mile, the resistance of forty such miles being in the battery, fifty in the line, and thirty-five in the receiving sounder.

41. Resistances that are not connected in series, but side by side, or as it is termed "*in multiple arc,*" cannot of course be additive, for between the points they connect there is more than one path, and the conductivity is increased by each additional path so introduced. We therefore have in this case the conductivities additive. Suppose A B C and A D C to be two wires connected at A and C, and each offering 5ω, then the conductivities of these wires are each $\frac{1}{5}$ or 0·2 mho. The double conductor may be regarded as a single conductor of double sectional area, so that we know its conductivity will be doubled, that is 0·4 mho, and the resistance of the two together, or, as it is termed, their *joint resistance*, will be $\frac{1}{\cdot 4}$ or 2·5ω, half that of either branch. So that the joint resistance of two equal wires is half that of one, of three equal wires one-third that of one, of ten one-tenth, and so on. When, however, the wires are not equal the case, though not so simple, is similar. Thus if in Fig. 13 A B C

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had 10ω, while A D C had 20ω, then the conductivity of A B C would be $\frac{1}{10}$ or 0·1 mho, that of A D C $\frac{1}{20}$ or 0·05 mho. The joint conductivity is their sum, 0·1 + 0·05, or 0·15 mho—that is, $\frac{1}{0·15}$, or 6·667ω, and similarly with any number of parallel conductors. For example, in Fig. 14 five resistances are shown in multiple arc, of 150ω, 60ω, 55ω, 2,000ω, and 80ω respectively; their conductivities will therefore be $\frac{1}{150}$, $\frac{1}{60}$, $\frac{1}{55}$, $\frac{1}{2000}$, $\frac{1}{80}$ mhos respectively—that is 0·006667, 0·016667, 0·018182, 0·000500 and 0·012500 mhos. The joint

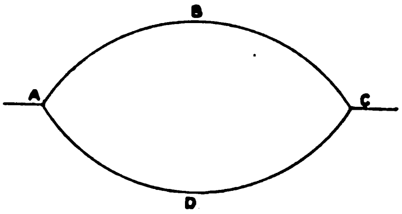

Fig. 13.

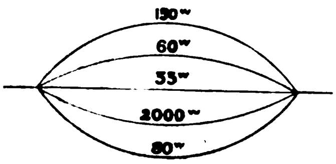

Fig. 14.

conductivity will be the sum of all these, namely, 0·054516 mhos, and the joint resistance will be $\frac{1}{0·054516}$, or 18·343ω.

Chapter V.

Current.

42. Having examined the nature of electromotive force as supplied by batteries, and of resistance, we are now in a position to deal with the laws which relate to the current which flows in any given circuit, laws which are among the simplest yet most important considerations of the subject.

43. Reverting to our typical form of simple cell at Fig. 1, page 31, we saw that no current flowed in the circuit B E F G H if the wire F G H were severed at any point. When a circuit is interrupted at any point it is said to be *opened* or *broken*, and when re-established to be *completed* or *closed*. Every possible circuit, even though it may embrace, as in telegraphy, hundreds of miles of conductor, and the earth itself between that conductor's terminals, may be regarded as a simple extension of that wire F G H, and hence a current in a circuit ceases and recommences upon the complete opening and closing of that circuit at any point, even though in the battery itself, as, for example, by withdrawing and replacing a battery plate in its cell.

44. Fig. 15 represents the simplest form of telegraphic circuit. A, B, and C are supposed to be three stations connected by the overhead conductors A B and B C. At each station there is a key, K, a sounder, S, and a switch, *s*. At A there is a battery, B, one pole of which goes to the key and the other is connected to the earth, say by a large metal plate buried in the ground. A similar earth connection is made at C. The switches have each two positions when turned to the right, as at B they break connection between the key terminals; and when turned to the left they re-establish it by making contact at *c*. The keys remain up while at rest through the action of a spring. If, now, all the switches are turned to the left or closed, a complete circuit is formed from the battery through s_1 S_1 A B, s_2 S_2 B C, s_3 S_3 and the earth, and a current will therefore flow through all the three sounders. The action of the current on the sounder we shall not at present consider, but it will suffice to observe that when the current passes through the wire of its coils, those coils attract the soft iron cross-piece or *armature* on the beam above, and pull it down against the attraction of the spiral spring *p*. If, now, B opens his switch by turning it to the right the circuit is completely interrupted at his key, the current ceases, the spiral springs reassert their control over the armatures, which rise to their upper limiting stops. If, now, B depresses his key for a single moment and releases it again, he will have closed the circuit during that moment at the key contact, the current will have passed during that interval, and caused the armatures of all three sounders to be attracted down to their lower stops, only to recoil again when the key K_2 rises; so that whatever contacts B makes, whether long or short, at his key, will be faithfully reproduced on all three sounders, whose armature levers follow, in fact, all the up and down motions of B's key. When B has finished sending he closes his switch, and either A or C can open their switches and reply to him in the same way. Thus, with one battery, E, any convenient number of stations can communicate with each other along a line of conductor by inserting a key, switch and sounder. This system is called the closed-circuit system, already alluded to in paragraph 16. It is in almost universal use in the United States, but is not so suitable for the conditions of European telegraphy, and is scarcely employed at all in England, one great disadvantage being the waste of battery power while the circuit is silent, as the current is normally always flowing.

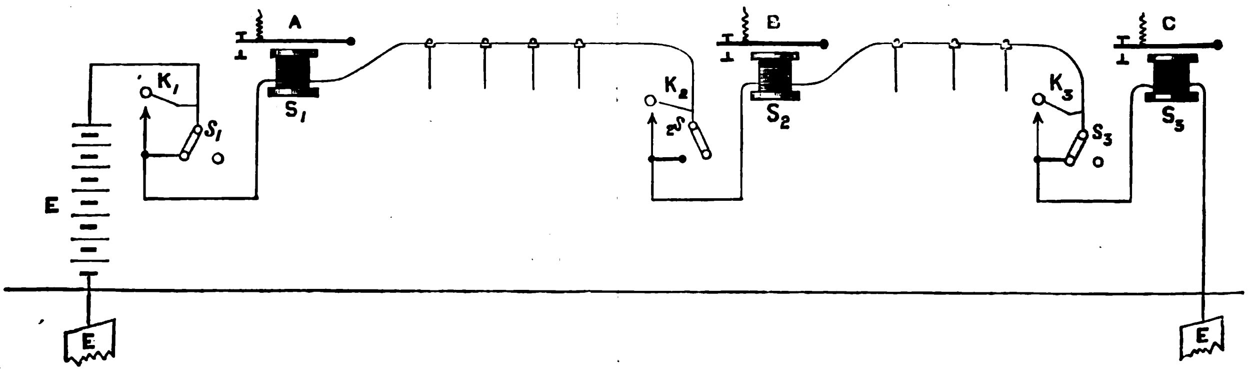

Fig. 15.

45. The instant such a circuit as that in Fig. 14 is closed a current commences to flow, but it does not instantaneously arrive at its full ultimate strength. A certain amount of time is required for the current to rise to its constant maximum limit, and this period of time is called the *variable period* of the current's flow. The duration of the variable period depends not only upon the nature of the circuit itself,

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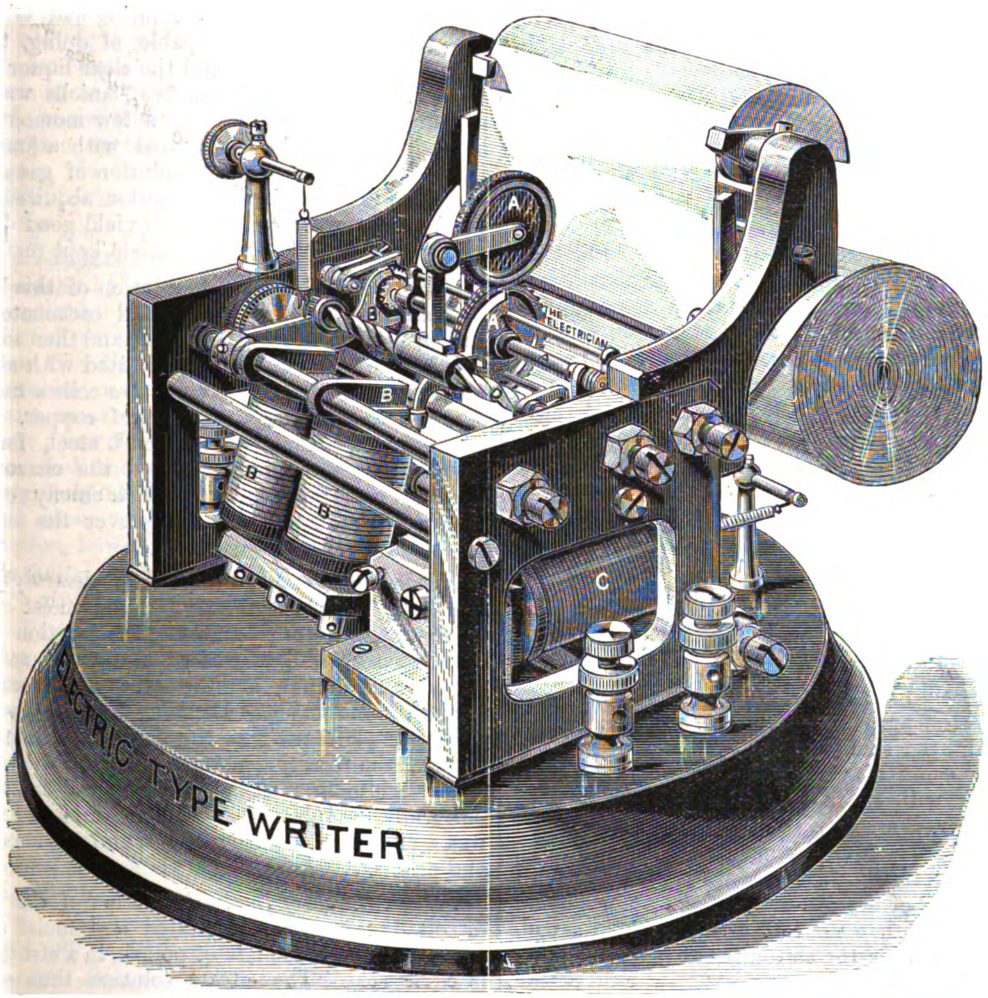
but also upon the nature of the space surrounding it; other things being equal, however, it increases with the length of the conductor. Practically, however, the variable period is in the case of overhead land lines exceedingly short. For example, with an ordinary No. 8 overhead wire 100 miles in length, with a battery and earth at one end and earth at the other—that is to say, with no telegraph instruments—the current at the end distant from the battery would arrive at 99 per cent. of its ultimate maximum value in 0·0021 second, or about $\frac{1}{500}$th part of a second, so that although the duration of the variable period is increased by the introduction of receiving apparatus into the circuit, still that period is with overhead lines so short that it may be neglected, except on lines worked at a very high signalling speed.

(To be continued.)

AN ELECTRICAL TYPE WRITER.

BY MR. F HIGGINS.

This apparatus, which fulfils the functions of a type writer at any distance from the keyboard, consists of a type wheel, which contains the letters of the alphabet, numerals, and stops. The rotation of the type wheel is effected by means of intermittent currents transmitted from a commutator under the control of a pianoforte keyboard acting on propelment pallets carried by the lever suspended over an electro-magnet. The number of currents transmitted determines the position of the type wheel with respect to the swinging frame, which serves as a guide to the paper and at the same time as a platen to make the impression. This frame is pivoted at its end, and carries an armature which is acted upon by an electro-magnet.



A A A Type Wheel Axle and Ink Loller. B B B Type Propelling Pallett and Armature Magnet.
C Printing Magnet. D Screw fcr Returning Type to Zero.

The type wheel is automatically traversed horizontally after the printing of each letter, in order to take up a position for the succeeding character until the end of the line is reached, when the operator restores the type wheel to the starting position by pressing the appropriate key. At the time this takes place the paper is advanced sufficiently to space between the lines, and the operator may by making successive contacts rapidly advance the paper as much as may be required either to commence a fresh subject or to eject sufficient paper to bring the end of the message well into view.

The lateral spacing of the characters is uniform, and is determined by the printing operation. The platen frame in falling back rotates a screw which carries the type wheel and ink roller. The spacing between the lines and the return of the type wheel to the starting point are effected at the same time by pressing a key which corresponds to a position on the commutator and the type wheel which is not occupied by a letter. A pin projecting from the type axis at this point causes the intervention of a block which acts as a fulcrum to a lever connected to and worked by the platen, but which only

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comes into operation to release the type wheel when thus provided with a fulcrum, and consequently only when the act of printing takes place with the type wheel in this position. A spring returns the type wheel to zero.

Synchronising between the receiving and transmitting apparatus is secured by means of a lever, which is geared to a type axis by friction, and is carried by the revolution of the latter into the path of a projecting pin. Upon a print being made this lever is reset at its starting point, but should three revolutions of the type wheel be made without a print the wheel will be arrested at zero. By commencing a message always upon the zero or spacing key of the transmitter the apparatus will be in unison.

Ink is supplied from an inking wheel in the usual manner.

INCANDESCENT LAMP MANUFACTURE.—AMYLOID CARBONS.

BY NELSON K. CHERRILL.

Mr. Swinburne says in his article No. III. (*Electrician*, Vol. XVIII., p. 122) that it is very difficult to get the production of amyloid constant in quality during manufacture, and I fully agree with him. But besides the causes of variation to which he refers there are, I think, others of perhaps more importance because less obvious at the moment.

Of course, in manufacturing on a large scale the supply of cotton would be derived constantly from the same source, and consequently one might be led to imagine that the product, so far as the cotton itself was concerned, would be very constant in its quality. But there are some considerations which would seem to show that this is not altogether the case. If we take the cottons of several different makers we shall find on trial very appreciable differences in the time of immersion necessary for proper conversion, or in the strength of acid necessary for conversion in the same time. I have met with one sample of cotton which remained unaffected by the acid even after a very prolonged immersion. Now, wherein do the differences between each sample from different makers mainly lie? I think it is chiefly in the cleaning or bleaching to which the cotton has been subject in the course of its manufacture. If the cottons of several makers be thrown together there will be found many differences of whiteness between them, and from this I gather that bleaching is carried on to a greater or less extent. Now if the varied amount of bleaching used by various makers produces a marked difference in the process, would not variations in quality (for electrical purposes) be produced by variations in the bleach action in the same manufacture?

There is another cause of variation which may be even more important. It will be found referred to in a very interesting book by Mr. Bowman on the "Structure of Cotton Fibre," published in 1881. Mr. Bowman describes, p. 55 *et. seq.*, "cotton oil" and "cotton wax," and from what he says I gather that the cell walls of the cotton fibre are impregnated with a kind of oil which, when the cotton is new, is in a condition of oil, but which, when the cotton is old, hardens more into the condition of a wax. Spinners say "new crop cotton has more nature is it." The quantity of this oil or wax also appears to depend on the ripeness of the cotton when gathered.

Now, I think, it is easy to see that the presence of such a substance as this in the cell walls of the cotton fibre may be an important factor in the final result; and especially as it is represented as undergoing a gradual change, as the cotton is kept, it may not unlikely be a fertile source of those variations in quality to which carbons made by the thread-immersing process are without doubt subject.

In 1850 a Mr. Mercer brought out a process, called after him "mercerising," by which cotton fabrics were steeped in a solution of caustic soda of 1·3 to 1·4 sp. gr., after which the fabrics are said to become much fuller and stronger. Mr. Bowman, in treating of this process, does not account for the action, but one would imagine that it had some very definite connection with the removal of the oil or wax above referred to. The writer tried a good many experiments in the direction of using "mercerised" thread for the production of carbons, and although these experiments were not extended to any large scale, there is good reason to think that carbons of much greater uniformity can be produced by preliminary chemical treatment directed against the cotton, oil or wax.

ELECTROLYSIS OF IRON SALTS.

BY ALEXANDER WATT.

(Continued from page 136.)

Double Carbonate of Sesquioxide of Iron and Soda.—In this experiment it was desired to ascertain what kind of a deposit would be obtained from an alkaline solution. To form the electrolyte, a strong solution of bicarbonate of soda was first prepared, into which freshly precipitated carbonate of iron was gradually introduced, and the mixture well stirred. When it was found that the soda solution had taken up as much of the iron salt as it was capable of doing, the vessel was set aside for an hour or so, and the clear liquor then decanted off for use. The current from five Daniells was employed, and a copper cathode as before. In a few moments after immersion the copper plate became coated with a fine white deposit of iron. There was a brisk evolution of gas at both electrodes, and after a short time the solution acquired a brownish tint; the bath, however, continued to yield good deposits of iron for a considerable time, and the anode kept remarkably clean.

Sodio-Citrate of Iron.—A solution of this salt was prepared by dissolving recently precipitated carbonate of iron in a hot and strong solution of citric acid, and then adding carbonate of soda. The solution was next diluted with about two parts of water. With the current from five cells a metallic deposit was obtained at once upon a strip of copper, but this quickly assumed the colour of "blued" steel, for an instant only, however, when it again acquired the characteristic colour of metallic iron; the deposit, which chiefly occupied the lower surface of the plate, refused to cover the surface nearest the top of the fluid.

Acetates of Iron and Soda.—The electrolyte was formed by dissolving recently precipitated and moist carbonate of iron in acetic acid to saturation; the solution was then diluted with twice its bulk of water; acetate of soda was then dissolved in the liquid, and the solution was ready for use. The current from five small Daniells, in series, was employed, and a copper plate used as the cathode. Immediately after immersing the receiving plate it became coated with a bright and silvery white film of iron, the deposition taking place very uniformly, and the coating well retaining its character. There was a moderate evolution of gas, and the anode remained clean and bright.

Potassio-Citrate of Iron.—A solution of this salt was made by dissolving recently precipitated and moist carbonate of iron, prepared with carbonate of potash, in a strong and hot solution of citric acid. The citrate solution thus obtained was then neutralised with carbonate of potash, and was then tried in its concentrated form, when the receiving plate (a strip of sheet copper) soon became coated with a metallic film of a dark green colour. The liquid was next diluted, and a fresh plate immersed, which at once received a coating of bright metal, but not of so good a colour as that obtained from the simple citrate of iron. The plate was allowed to remain stationary for a minute or two, when the dark green film again appeared upon its surface. A freshly-prepared plate was now substituted, and this was kept in brisk motion while in the bath, when a silvery white film was obtained which strongly adhered to the plate. The solution was now further diluted to see if a bright reguline deposit could be obtained upon a stationary plate. Such was not the case, however, for shortly after a layer of white metal had been deposited, the coating again became covered with a dark green film. When a newly-pre-

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pared plate was immersed, and kept in rapid motion, the deposit was of a good reguline character, very white, and, as before, very strongly adherent. In working this solution it was noticed that the metallic deposit, as in some other cases, commenced at the upper portion of the cathode, gradually proceeding downwards.

Chlorides of Iron and Potassium.—Solutions of the respective salts were mixed, and electrolysed with a current from two small Daniells. Only a slight trace of metal appeared upon the upper part of the cathode, while a copious dark green salt was formed, which in a few minutes floated on the surface of the liquid to the depth of about half an inch.

Perchloride of Iron and Chloride of Potassium.—A solution of chloride of potash was added to one of perchloride of iron, and a current from two Daniells employed. A copper plate promptly became coated with a bright film of iron of good colour in this solution, the anode surface being about one-half that of the cathode. There was a brisk evolution of gas, with which the solution soon became impregnated throughout. After a short immersion the plate became spotted in parts with minute dark specks, which were easily removed by scouring with silver sand. The plate being again returned to the bath received a further coating of white metal, which appeared to be exceedingly tough, for electrolytic iron, for when a corner of the coated plate was turned down, forming a sharp bend, there was no evidence of the deposited metal having separated from the underlying surface of copper. It was noticed that the anode kept perfectly clean during the electrolysis. This result from a persalt of iron was highly satisfactory.

Magnesio-Citrate of Iron.—The electrolyte was formed by dissolving freshly precipitated carbonate of iron in a strong hot solution of citric acid and then adding hydrated carbonate of magnesia until the solution was nearly neutral. The liquid, when cold, was diluted with about twice its bulk of water. With a current from two Daniells a good deposit of iron, but of a greyish white colour, was at once obtained upon a copper plate. After a short immersion the coating become streaky and of a dark colour; two more cells were then connected, and an addition of citric acid made to the bath, when the character of the deposit was greatly improved, and it soon assumed a fairly good white colour, and adhered well to the copper surface. This solution, however, like the sodio-citrate, is inferior to the simple proto-citrate, from which much better results can be obtained.

Borate of Iron.—To prepare a solution of this salt a quantity of freshly precipitated and moist carbonate of iron was digested for some time in a nearly boiling solution of boracic acid. Although the carbonate is but sparingly soluble in this acid, the resulting solution, when diluted with about twice its bulk of water, formed an electrolyte from which a good bright deposit of iron was obtained upon both sides of a copper plate immediately after immersion. The current from five Daniells was used, and the surface of the electrodes was about equal. During the electrolysis the anode kept perfectly bright and clean, and the deposit maintained a uniformly bright surface throughout the trial. It should be mentioned that an excess of boracic acid was given to the liquid.

Sulphates of Iron and Soda.—A solution of the mixed salts was prepared by adding to a solution of sulphate of iron (one ounce of sulphate in ten ounces of water) about an equal quantity of a solution of sulphate of soda. With the current from five Daniells, and about equal electrode surface, a fine white and uniform coating of iron was obtained upon a copper plate a few seconds after immersion, and the deposition proceeded with perfect uniformity and with great rapidity, a good coating being received upon the plate in about a quarter of an hour. It seems probable that a bath prepared from these salts, with such modification of density as a larger trial might suggest, would prove a useful electrolyte for depositing iron for practical purposes. A second plate was next placed in the bath, and allowed to remain for a longer period, when, as before, a perfectly uniform deposit was obtained, while the anode still retained its brightness, and exhibited signs of having been freely acted upon. On examining the solution (which was faintly acid) after the trial there was no evidence of oxidation on its surface. It should be mentioned that the deposit took place on both sides of the cathode, the back of the plate being fairly coated with iron a few seconds after immersion, indicating that this bath is a very good conductor. In many of the solutions of iron salts which I have electrolysed during these experiments, the front of the cathode—that is, the surface facing the anode—alone received a deposit of metal, while in some instances there was only a partial disposition for the metal to deposit on the back of the plate. In several instances the film positively refused to make its appearance on this surface of the negative electrode. In the present case the deposition commenced at the bottom of the plate and continued upward, which, as I have shown, is not always the case; indeed, I have known many instances in which it has been practically impossible to obtain a coating of metal upon the corners and lower edges of the cathode, even when the upper part of the plate has been coated with metal. When this peculiarity shows itself, however, it is a sure sign that the solution is an indifferent conductor.

Pyrophosphate of Iron.—A solution of this salt was prepared as follows:—A moderately strong solution of the pyrophosphate of soda was first obtained, and into this was poured, gradually, a solution of persulphate of iron. The mixture being well stirred, the resulting precipitate rapidly became dissolved, when fresh additions of the iron salt were added to nearly the point of saturation. The solution thus obtained was worked with five Daniells. In a few moments there was a moderate evolution of gas, and a dark brown salt became formed at the cathode. The plate after remaining in the bath for about five minutes was examined, when a dark blue horizontal streak of iron appeared on its upper surface, but no metal had deposited upon the remainder of the plate. On raising the anode it was found to be covered with a thick white and dense mass, which had apparently stopped the passage of the current. Beyond these effects no result could be obtained from this solution.

(To be continued.)

ELWELL-PARKER'S ELECTRIC TRAMCAR.

Messrs. Elwell-Parker have recently designed a special type of motor for tramcar work which embodies high efficiency with slow speed. A machine of this type capable of exerting 25 horse-power runs at 350 revolutions and weighs 2,000lbs. A car fitted with this motor and supplied with E.P.S. storage cells was recently tried on the Willenhall line of the Wolverhampton Tramways Company. The car has been built at Shrewsbury for Messrs. Elwell Parker (Limited), of Commercial-road, Wolverhampton, who are preparing it for the Australasian Electric Tramway Company, by whom, should it give satisfaction, it will in all probability be generally adopted.

The motor drives direct on to the axle of the car by steel chain gearing. At the trial an incline of 1 in 15 was readily surmounted. We hope shortly to give some further details of this machine.

MEETINGS OF SCIENTIFIC SOCIETIES.

(Week ending Thursday, 29th December.)

TUESDAY, December 27th.

ROYAL INSTITUTION.

3 p.m. The First of a Series of Six Lectures (adapted to a Juvenile Auditory) on Astronomy. By Sir ROBERT STAWELL BALL, LL.D., F.R.S.

THURSDAY, December 29th.

3 p.m. The Second Lecture of the above-mentioned series.

*** Particulars of meetings to be held or papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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The Electrician.

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ANSWER TO CORRESPONDENT.

"A POOR VICTIM."—*See our Editorial Note on this.*

THE BRADFORD CORPORATION AND THE ELECTRIC LIGHT.

The important decision arrived at by the Corporation of Bradford with regard to the electric lighting of that town furnishes material for reflections which, if not peculiarly seasonable, are at all events sufficiently agreeable and cheering to be appropriate for the Christmastide now close upon us. Bradford is not exactly the sort of place to which one's thoughts naturally wander at this season of the year; but it has the merit of being far away from the metropolis, where bustle and confusion now reign supreme for a whole fortnight, and where hardly any business of a serious kind is so much as thought of. There are some sweet spots in Yorkshire that have pleasant memories for us, and, writing as we do, with the din of London in our ears, and its fogs in our eyes, we conjure up the Christmas of old—the sunny morning, the crisp air, the frosty road, the holly-hung church and the village choir—a picture which, if it still survives, has to be sought for a good many miles away from Salisbury-court. The people of Bradford are more happily situated than we in this respect; an hour's walk in any direction will take them to scenes where an orthodox Christmas can be realised, and perhaps this will account for our attention being attracted there at this moment.

What first strikes us in reperusing the report of the Corporation meeting published in our last week's issue is the singular good fortune of the town of Bradford in having a body of men to manage its affairs whose aim appears to be to fulfil their public obligations and to provide for the welfare of the inhabitants. This, at all events, is the case if Mr. Alderman PRIESTMAN may be taken as a fair sample of the whole Council. His address on the occasion to which we refer, when the report of the Gas Committee came up for consideration, was a model of candour, fairness, and sound judgment; and showed, moreover, a quite exceptional—exceptional certainly in Town Councils—mastery of the technical features of the scheme he had to lay before the meeting. The scheme in question, as our readers are aware, contemplates providing a certain area of the borough with an installation for electric lighting, the initial cost of which is not to exceed £15,000. It is not a large undertaking, therefore; but its

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past history is instructive, and the conditions under which it is to be carried out, as well as the objects intended to be accomplished by its instrumentality, are well deserving the attention of electrical engineers. It is Mr. PRIESTMAN's statement on these several heads that especially provokes our admiration.

It should be borne in mind that the Corporation of Bradford is the owner of the gasworks supplying the borough, and that to introduce a rival illuminant the most formidable of all conflicting claims—namely, self-interest—has to be overcome. That Bradford has at length satisfied itself that its gas-supplying business will not suffer, or, if it does, will be compensated for by the new business of supplying electric light, is a fact of great significance, and one which may probably lead to a similar duplication of functions in other important towns besides Bradford. Three or four years ago the Corporation of Bradford, like some other corporations possessing monopolies of gas lighting, took alarm at the sudden popularity of the electric light; and after successfully opposing the application of a London company to supply Bradford with electricity, the Corporation sought and obtained a Provisional Order under the Electric Lighting Act to supply the commodity themselves. As a matter of fact, some delay took place in acting on the powers thus obtained; and meanwhile a local company has actually effected an installation in one district of the borough, though hampered by the authority which the Corporation possess of prohibiting electric light wires over the streets. Into the merits of the dispute between the private company and the Corporation we need not enter here, further than to remind both parties that they voluntarily incurred each a certain risk—the one by invading the rights of the borough, the other by permitting its rights to be invaded. Of the two we are inclined to think the Corporation are most responsible, seeing that by condoning a private installation in the first instance they virtually confessed they had no intention of doing the work themselves. These considerations ought to, and no doubt will, assist the disputants in arriving at an amicable settlement of their present conflicting claims.

But whatever may have been the cause of this delay, the Corporation have now come to a bolder and, we must add, a more honourable resolution. Alderman PRIESTMAN reminded the Council—and it is a reminder we should like to see published very widely—that the Parliamentary powers granted to the Corporation were conditional on their being used, and were not intended merely to be employed as a shield against competition. On the contrary, every Provisional Order stipulates that if action upon it is needlessly deferred its powers may be tranferred to other persons. This point being made clear, the Council agreed with the Gas Committee that the right thing, as well as the wise thing, was to take action on their own Provisional Order. The committee recommended as a tentative experiment a small installation to be undertaken at once which could be tested during the coming spring and summer months; and, if successful, further authority would be asked to extend it later on. The plan already foreshadowed seems to be a good one so far as it goes, and if carried out under efficient supervision, and with an honest desire that it shall succeed, we have every confidence in its final, though of course gradual, adoption over a very much wider area. It is well not to start too ambitiously; and perhaps Mr. PRIESTMAN was discreet in stating that many people in the town had told him that if the price of electricity was double the present charge for gas in Bradford they would be glad to pay the higher figure for the purer article. If matters are managed properly there will be no need to tax the consumers to this extent; but at Bradford, as elsewhere, the expenditure on ventilating the public buildings ought to be taken into account, especially as the process is usually like the ventilation of our pockets at Christmas time, serving mainly to let the money out freely. The Bradford Town Hall has cost a considerable sum already in ventilating experiments, and £1,000 more was designed to go in the same direction. The electric light may save this.

Perhaps one of the most attractive features of the programme described by Mr. PRIESTMAN was the probable application of electricity to the industrial life of Bradford. He anticipated, with some show of probability, that one result of providing an electric installation would be the introduction of additional trades into the town. Applications have already reached the authorities from electro-platers to come to that place and establish their business there. Where a small motive power was required, Mr. PRIESTMAN observed, he had no doubt electricity would be extensively used; and it was not unlikely that the town tramcars would before long be driven by electricity if the companies could obtain the power from such a source as the Corporation intended to provide. This is the sort of scheme to make electricity pay, and whether undertaken by private enterprise or a public body is one which we hope to see carried out more generally during the ensuing year. The revival of trade in the closing weeks of 1887 is an encouraging sign for the country; and with improving prosperity we may confidently look forward to a rapid development of electrical industry. In this conviction our readers may depart on their holiday with easier minds, and accept our seasonable greetings, which we offer with much heartiness, in the spirit of hopefulness and courage which an old-fashioned Christmas was wont to inspire.

OBITUARY NOTICES.

PROF. BALFOUR STEWART.

It is with considerable surprise as well as profound regret that his friends and fellow-workers at Owens College, Manchester, have received the intelligence of Prof. Stewart's sudden death at his house at Drogheda, last Sunday night or early Monday morning. The professor was in Manchester on the previous Friday, and, to all appearance, enjoying his customary excellent health and spirits. He had been working specially hard, it is true, owing to the absence of his wife, who usually assisted him, and on the Tuesday he had called in a doctor for what appeared to be merely a temporary indisposition; but otherwise there was not the least cause for uneasiness, and down to the time of our going to press the actual cause of Prof. Stewart's death has not reached his friends in England.

Balfour Stewart was educated at Edinburgh University (where he graduated M.A.) with a view to a commercial career, and spent some years of his early life in Australia. His attention was soon concentrated on the phenomena of radiation and absorption of heat, and his experimental investigations in that department of physics made his name known in the scientific world. He achieved a prominent place in the early progress and development of spectrum analysis. The Royal Society acknowledged the great value of his work by electing him a Fellow in the year 1862, and by awarding him the Rumford Medal in 1868. He held for about ten years the directorship of the Kew Observatory. The greater part of his attention was now turned to the development of the subject of terrestrial magnetism, and that branch of science will be a great loser by his death. Of late years, in his capacity of secretary to a committee of the British Association, he served as a connecting link between the scientific man and the observer in all questions concerning terrestrial magnetism. While he was at Kew he established the self-registering instruments by

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means of which any change in the direction and intensity of magnetic force is automatically printed. The connection between the mysterious sunspot period and terrestrial phenomena fascinated him, and he was fertile in new suggestions and valuable contributions towards a solution of these very difficult questions. In 1870 he was appointed Professor of Physics at Owens College and Director of the Physical Laboratory; and at the time of his death he was also President of the Physical Society of London, and of the Manchester Literary and Philosophical Society.

Prof. Stewart was the author of several valuable scientific text-books on Heat and Physics, and of many important papers, some in conjunction with Prof. Tait, Mr. De La Rue, and Mr. Loewy. He leaves unfinished a work on Practical Physics, two volumes of which only are completed. Of the other well-known work with which his name will be always identified, and of the religious bent of Prof. Stewart's mind, the *Manchester Examiner* speaks as follows :—

"Of deep religious conviction and a believer in Christianity, Prof. Balfour Stewart directed his active mind to some of the problems which extend farther than the solution of purely physical questions. He wrote in association with Prof. Tait a work now very widely known, entitled 'The Unseen Universe.' Few books of the day have aroused more thought or discussion, and it has been widely circulated, having passed through ten editions. In this treatise the keen scientific bent of mind which distinguished Prof. Stewart was joined to a calm investigation of supernatural phenomena. He became President of the Society for Psychical Research founded in 1882, and delivered an opening address at a general meeting of that society in June, 1884. Prof. Stewart was a member of the Church of England, and took an active interest in its concerns. He was connected with the Christian Evidence Society."

The lamented professor was in his sixtieth year.

FRANCIS C. GUILLEAUME.

In our issue of the 9th inst. we announced the death, at his residence in Cologne, of Mr. F. C. Guilleaume, the proprietor of the firm of Messrs. Felten and Guilleaume, of Mülheim-on-the-Rhine, and 101, Leadenhall-street, London, E.C., the well-known wire drawers, telegraph engineers, and manufacturers of telegraph cables, wire rope, barb wire, &c.

The deceased gentleman was born on the 30th December, 1834, and in 1865 succeeded to the sole proprietorship of the business, which, in consequence of his energetic management, has now become one of the largest, if not indeed the largest, of its kind.

Amongst the many extensive operations which Mr. F. C. Guilleaume successfully carried out may be especially mentioned the German underground system of telegraphy, which was commenced in 1876, the first cable being a length of 105 miles, from Berlin to Hallé. This proved so satisfactory that the Government subsequently decided to construct a complete network of underground telegraph cables, the total length being 3,390 miles, which for the most part were manufactured and laid by Messrs. Felten and Guilleaume.

As some recognition of the services he had rendered to industry, Mr. F. C. Guilleaume was made Chevalier of the Legion of Honour by the French Republic, by the King of Prussia he was decorated with the "Order of the Crown," and also received the title "Councillor of Commerce."

The deceased was possessed of deep penetration in commercial affairs, and the present prominent position of the firm is due solely to his restless energy and keen spirit of enterprise.

The works at Mülheim find employment for upwards of 2,500 hands, and the deceased gentleman, while being foremost in the fierce struggle in the markets of the world, did not forget the comfort and welfare of his workmen. For their benefit he invested large sums of money, and he founded for them many provident institutions, amongst which may be mentioned a fund for the support of aged workmen, for the widows of officials and foremen, and of those workpeople who are reduced through circumstances beyond their control. He also erected numerous dwellings, which are exemplary from a sanitary point of view, besides a co-operative stores and a savings bank, and we must not omit to mention the Crèche Institute for taking charge of the workpeople's infants during the day.

The funeral, which took place on the 5th inst., was an imposing sight, and at the same time a touching tribute to the memory of the deceased, not only as an acknowledgement of his abilities and achievements, but also of the interest he had always manifested for the welfare of his workmen, and thousands of people hastened to obtain a glimpse of the vast *cortége*. So large, indeed, was the procession that it took fully an hour to reach the cemetery, and besides relatives and friends the deceased was followed to his last resting place by the highest officials in both military and civil circles.

By the death of Mr. F. C. Guilleaume industry has lost one of its most ardent promoters, and his name will long be remembered as amongst those who have always had at heart the real interest of mankind.

The deceased leaves behind him a widow, three sons, and two daughters. The business will be taken over by the eldest son, Mr. Theodore Guilleaume, who has greatly assisted in the management for some years past.

SWAN'S MINING LAMP AND FIRE-DAMP INDICATOR.*

Since it has been ascertained that a very small proportion of fire-damp is sufficient to produce an explosive mixture with air heavily laden with coal dust, the old tests for the presence of fire-damp in coal mines have become entirely insufficient. Less than one per cent. of fire damp may, under certain well-known circumstances, be quite enough to originate a disastrous explosion, and hence it has become a matter of vital interest to ascertain the presence of small proportions of fire-damp in pit air. The usual means employed in testing for fire-damp is the flame of the safety lamp. The flame of a safety lamp will show by elongation when the air has become foul to the extent of 2 per cent. of fire damp, but it will show nothing at all if the proportion is less than 1 or 2 per cent., and yet 1 or 2 per cent. is quite a dangerous proportion if the air is heavily laden with coal dust, and there happens to be a long tongue of flame projected into it by a blown out shot.

I have been lately striving to supply the want of a more sensitive indicator of fire-damp, and the outcome of my effort is the apparatus before you. Before describing the apparatus I will explain the principle upon which it acts.

If we make a mixture of atmospheric air and fire-damp, and introduce into the mixture a red hot wire, combination takes place between the hydrogen of the fire-damp and the oxygen of the air, and a result of the combination is that the gaseous mixture shrinks or tends to shrink in volume. It is easy to conceive that this shrinkage, or tendency to shrink, in the volume of the gaseous mixture consequent on combustion, may be made the basis of a fire-damp indicator, for one has simply to adapt a sort of pressure-gauge to the vessel in which the combination takes place, and then the indications of the pressure-gauge correspond with the proportions of fire-damp burnt by the action of the hot wire. In the apparatus designed by me on this principle, for practical use in coal mines, in searching for gas—especially for small proportions of gas—there is a portable voltaic battery, composed of lead and oxide of lead, in dilute sulphuric acid, for the purpose of heating the wire.

This particular construction of the battery is not essential. It may be constructed (and I have sometimes so constructed it) of zinc and peroxide of lead in dilute sulphuric acid. All that is essential is a portable voltaic battery that will, without fail, make a few inches of small wire red hot, that will not be apt to go out of order, or alter much in electromotive force after being used to make a number of tests.

* Paper read before the British Association, September, 1887.

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I know of no battery that fulfils all these requirements so well as the lead and oxide of lead secondary battery, constructed on the principle discovered essentially by Planté. Its electromotive force is high and comparatively constant; when the battery is properly made there is very little local action, it is easily charged, and the materials cost very little. The function of the battery is to make the combustion wire of the gas apparatus red hot.

I have added an incandescent lamp to one side of the battery in order to provide a convenient means of examining the level of the pressure gauge. The indicator is connected with the battery by means of a pair of flexible wires twisted into a cord and enclosed in an india rubber tube. These wires convey from the battery the current necessary to make the combustion wire red hot. This wire is platinum ·002 of an inch in diameter, and is wound in a spiral. The length is adjusted so that the battery will just raise the spiral to a red heat.

The spiral of platinum is, as I have said, connected by its ends with the flexible wires of the battery. There is a switch interposed (at a convenient place for the thumb to press upon) to keep the circuit broken until the moment a test is required to be made. The combustion spiral is fixed within a brass tube with a stop cock at each end. The gauge tube is of glass, and is fixed into the under side of the brass tube so that the two form a T, of which the horizontal line is the brass combination tube, and the upright line the gauge. The bores of the combination tube and the gauge tube communicate with each other, and the gauge tube is enclosed in a glass tube open at the top and closed at the bottom, and this tube contains coloured glycerine and water. The bore of the gauge tube is expanded to a bulb, which has a very minute hole at the bottom. The bulb and small hole are for the purpose of preventing the projection of the liquid out of the gauge tube, and they effectually accomplish that purpose.

There is just one other point I must mention, and that is, that the taps are made to act as switches, so that the circuit cannot be closed unless the taps are also closed.

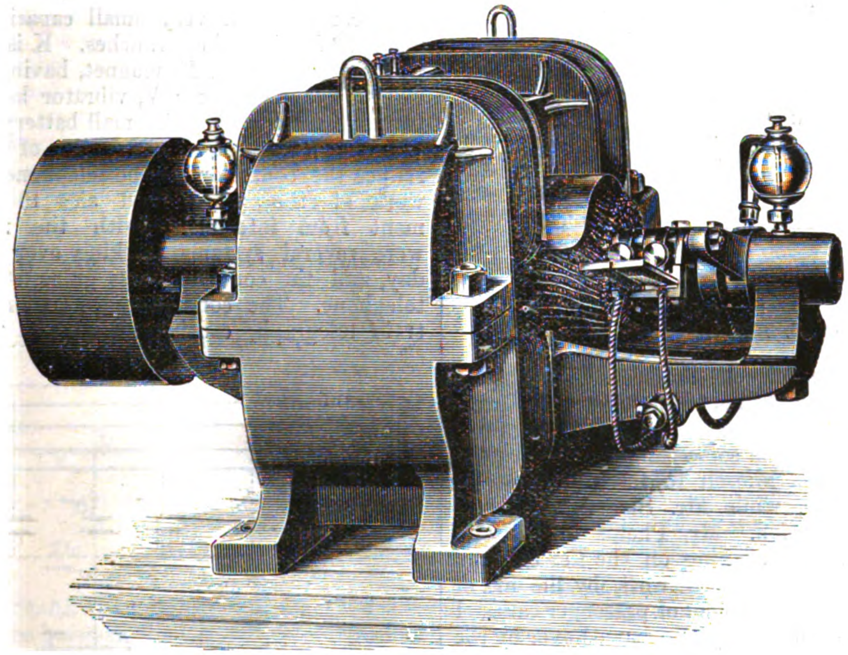
Now suppose the apparatus is taken into a coal pit, and that it is required that the air in the passages of the pit or in the workings should be tested for fire damp. All that has to be done is to pass the open combustion tube backwards and forwards a few times through the air, and then to close the taps and press the switch with the thumb during about 20 seconds, 10 seconds at a time, with a short interval between. The result of this will be that in a very short time (a few seconds if there is much fire-damp) the liquid will rise in the gauge tube above the level at which it stood at first, and the height to which it rises shows roughly the proportion of fire-damp in it.

By taking a longer time to more completely burn the fire-damp a nearly exact quantitive determination is obtained.

The degree of sensitiveness of the gauge is largely within control. By making the capacity of the combustion tube large, relatively to the calibre of the gauge tube, extreme sensitiveness is obtainable. I have found it convenient to make the bore of the gauge tube smaller for a certain distance at the lower end, and wider at the upper end. In that way I obtain both sensitiveness and range in small compass. In the tube I have here 1 per cent. of fire-damp will cause one inch rise of liquid in the gauge, and therefore it is easily readable to the $\frac{1}{8}$th of 1 per cent.

PARIS AND SCOTT'S NEW DYNAMO.

We illustrate herewith a dynamo of new type introduced by Messrs. Paris and Scott. The machine is intended to give 100 volts with 120 amperes at 850 revolutions. The field-magnets, which are of the double horseshoe type, are of cast iron, and their section is nearly three times that of the armature core. Notwithstanding this fact, and that of the moderate speed of driving, the maximum output of the machine is equal to 9·46 watts per lb. weight, the total weight being 1,268lb. The machine contains 207lb. of copper and 840lb. of magnetised iron, and measures over all 39in. in length, 30in. in width, and 21in. in height. The field is shunt-wound, and is excited with 6,292 ampere-turns on each limb. The current density in these coils is 866 amperes per square inch, and the current 2·86 amperes. The sectional area of the magnet cores is 99 square inches.



PARIS AND SCOTT'S NEW DYNAMO.

The armature is of the drum type, with Pacinotti teeth. In order to avoid the heating of the pole faces, which is apt to occur in machines of this type, owing to the non-uniform distribution of the lines of the armature field, the teeth are made very deep and narrow, and are set very close together. This not only secures a well-nigh uniform armature field, but it also prevents the disagreeable noise which toothed armatures are liable to produce. The armature measures 9in. in length, the outside diameter is 8in., and the depth of the slots 1in. The copper on the armature weighs 22lb., and is made up of 286ft. of six strands of No. 16 B.W.G. wound together,

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and having a total cross-sectional area of 0·0393 square inch. The resistance is 0·029 ohm, and the current density slightly over 3,000 amperes per square inch. The iron in the armature weighs 80lb., and the total weight of the armature is 147lb. The output is equivalent to 545 watts per lb. of copper on the armature. The voltage is a little over 2 volts per yard of armature conductor. The field strength in the core, according to the figures supplied us, works out at a very high figure, namely, to 23·6 lines per square inch, allowing for the shaft one-fifteenth of the total lines. There are 168 turns on the armature, and 42 parts in the commutator. The peripheral speed is low, being only 2,200ft. per minute.

The electrical efficiency is decidedly high considering this low speed, being 94·46 per cent. In the armature at full load 417 watts are lost, and in the field 286 watts.

The mechanical construction of this armature would appear to render the machine particularly suitable for motors—especially for tramcar and electric railway work. The iron plates are made with a hexagonal hole, and threaded on a hexagonal shaft so that every plate is driven direct, and as in addition to this the conductor lies in slots, it is evident that the construction is well calculated to bear a very heavy torque. The makers inform us that great attention has been paid throughout to the mechanical details, as "they consider that durability and freedom from breakdown are of *first* importance." In this view we entirely agree with Messrs. Paris and Scott.

In cases where lightness is an important consideration, as for some classes of motors and for ship-lighting, the field-magnets are made of wrought instead of cast iron. A machine of this character, with an output one-half of that just described, namely, 6,000 watts, and running at 1,000 revolutions, with an electrical efficiency of 93 per cent., weighed only 240lb., which is equivalent to an output of no less than 25 watts per lb. of dead weight.

TELEGRAPHING TO MOVING TRAINS.*

BY C. H. RUDD.

The pioneer names connected with the system of which I write are Lucius J. Phelps and William Wiley Smith. Messrs. Edison and Gilliland have taken a leading part in making practical applications, and have secured some claims on their own account. Mr. Phelps devoted himself to the principles involved in dynamic induction, while Mr. Smith turned his attention towards static induction. Mr. Phelps used a wire laid inside of a wooden stringer running on the ties between the rails. The Smith system does good work by the aid of existing telegraph lines and the tin roofs of passenger cars. I cannot, in this article, cover all the ground passed over by the gentlemen mentioned, but will try to give a fair idea of the work of each.

I have said that Mr. Phelps placed his main line inside a wooden stringer between the rails. This wire was grounded at the ends, and worked as a closed circuit. One method of car equipment was to place an electro-magnet under the body of the car, fastening the magnet in such position that it would run at right angles to and as near the track wire as possible. A current passing in the track wire would tend to magnetise the core of the magnet on the car and produce a current in the surrounding wire. In Fig. 1 W is a sectional view of track wire; K, double point key; T, hand telephone; R, back contact relay; M, magnet running near wire W. The key open closed the circuit through the hand telephone, and was in a position to receive. The key pressed to its front stop closed the circuit through a small battery and the relay, including the back contact, producing a buzz which went into the track wire by induction. This diagram of connections is correct for the track wire when magnet M is omitted. Mr. Phelps's first idea was that he could use polarised relays and sounders in his work, but experience did not bear him out. He substituted a hand telephone for the polarised relay, and made his signals with the buzzing current mentioned. I witnessed the operation of this system on the N. Y., N. H. and H. R. R. The track is double, and the wire was laid only on one track. The signals were clear and good, but much the best when the train was running directly over the main wire, as might be expected.

The system devised by Mr. Smith is peculiarly interesting, in that it grew out of the inventor's observations upon cross talk. It is a fine illustration of the fact that natural principles may be hurtful in one field and helpful in another. In describing this system, I will refer specifically to the arrangement used at the exhibition given on Staten Island, in February, 1886. The road extended from Clifton to Tottenville, thirteen miles. The B. and O. Telegraph Company had

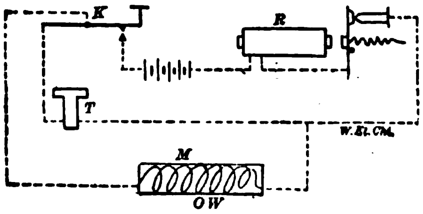

FIG. 1.

a line of thirty wires along the track. Five wires were chosen for the train telegraph. To these five wires half connections were made. Each of the branches thus formed was carried to a condenser of very small capacity. Fig. 2 shows the manner of using the branches. K is a double contact key; T, hand telephone; M, magnet, having only a primary winding of low resistance; V, vibrator kept in motion by local battery, not shown; B, small battery; C′ C″ C‴ C⁗ C′′′′′ C′′′′′′ are condensers. The action of the condensers was to reduce the confusion in the telephone caused by the regular work of the wires, and also to prevent the arrangement from interfering with the regular work. There were several systems working over the wires during the day, and the confusion was great when listened to in the telephone. The condensers discriminated in favour of the train telegraph, causing the signals to stand out alone. I

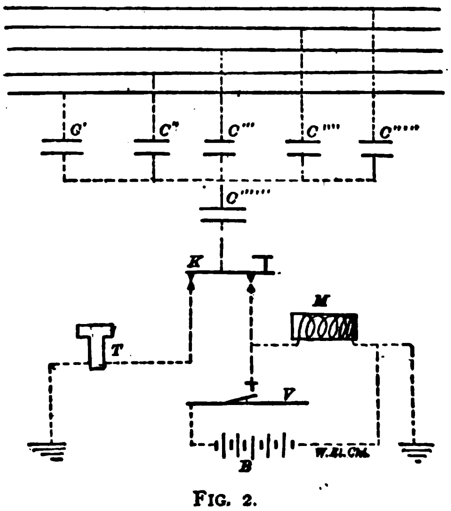

FIG. 2.

shall never forget my sensations when this style of connections proved successful. I was working upon the experiment in company with my friend S. K. Dingle, of New York. I was at the station, Mr. Dingle making the run from Clifton to Tottenville. Upon the day in question the run to Tottenville had proved very unsatisfactory. I lost communication almost immediately after the train left Clifton. It was in the middle of the day and the wires were heavy with work. I strained my ear to catch Mr. Dingle's signals, as long as the train was on the road, and then settled back in my chair to wait for the return trip. I had no particular desire for the return trip either, as I had no hope of better results. But something had to be done. Time was passing, anxious eyes were upon us, and failure was not to be thought of. We had

* From the *Western Electrician*.

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used a single wire, and the idea came to me to try a combination of wires and condensers. I was aroused, for the plan seemed to have some merit. I quickly made the necessary connections, and then eagerly waited for the train to start back. When the hour arrived I was listening at my telephone, and heard what I thought was some new sort of work passing upon the wires. It was a straight buzz, unlike anything that I had heard before. I listened intently, and after a moment or two the buzz broke into Morse signals. It was "D" calling "R." I reached for my key, and did not lose communication with Mr. Dingle until the train pulled into the station at Clifton, where the tin roof on the shed cut us off. The straight buzz which I heard was "D" adjusting.

The connections used on the train were as shown in Fig. 3, in which T is the hand telephone; K, double point key; C, regular induction coil—the fine wire being represented by the wave line and the coarse wire by the straight line; V, vibrator kept in motion by magnet and local battery not shown. The key on the back stop closes circuit from roof through telephone to ground, the ground being reached through the metal work of the car under the floor. The key pressed to the front stop closes the circuit from roof through fine wire of coil C to ground. Battery B passes through the vibrator points and the coarse wire of coil C. The tone of the vibrator is reproduced in the coil, and passes to the roof when so desired for signalling. Many experiments were tried to get just the right kind of coils. We settled on the plain primary for use in the station, and a regular induction coil for the car. It seemed to be necessary to charge the roof to a higher degree than was required for the wires. I think the track exerted more influence upon the roof than upon the wires, so that the roof had to sustain a heavier tax upon its inductive energies than the wires. At any rate, it was easier to work from the station to the train than from the train to the station.

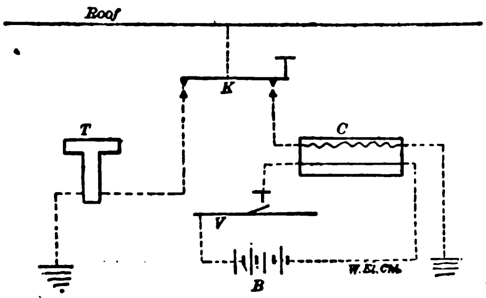

Fig. 3.

The operation of Mr. Smith's system depends upon the condenser action taking place between the tin roof, or roofs, and the neighbouring wires. With the arrangement which I have described, a charge passing to the roof is greater because of the nearness of the wires; and by just so much as this charge is greater is the strength of the train signal measured. When using the existing lines as a part of this system, it was customary to connect all the available roofs of the train together to increase inductive surface.

Late in the year 1886 some experiments were made in Western Iowa, on the C., M. and St. P. R. R. Mr. Dingle and I were still together, and had a construction train assigned to us. Instead of tin roofs we were obliged to use a flexible, insulated cord, strung on stakes set in the cars. This cord was left open at the distant end and connected to the apparatus in the caboose, just as a wire to a roof would have been connected. We did some very good work with this train. As a general thing the construction train had been working under cover of a flag or upon the best orders that could be given at the time of its departure from a telegraph station. When our arrangements were completed, we were able to follow the train wherever it might be working, and give it the advantage of any change in circumstances that favoured it, or get it out of the way of unexpected trains if necessary. In some cases we held communication over a space of one hundred and twenty-five feet between the lines and the train

At this stage of our work we came upon an unexpected enemy. One morning we began work as usual, and all went well. The train worked in a quite deep gravel pit over a hundred feet from the wires. I was in the despatcher's office and Mr. Dingle was on the train. About 10:30 a.m. I noticed a peculiar sound in the telephone, and wondered what new system of electrical work was operating in Omaha. In a little while the noise became troublesome. It would begin light and rise to a maximum, making a little explosion when it reached its highest point. These explosions would frequently cut a word out of something which the train was trying to say to me. This trouble grew worse until noon; but when the train pulled up out of the pit the margin was good enough to work over the noise. Up to noon the wires had been working smoothly. The weather was warm with a south-west wind blowing, and the sky filled with banks of fleecy clouds. I had no thought of atmospheric disturbance until shortly after noon, when the Morse relays began "clipping." The explosions in the telephone followed each other in quick succession, and work with the train ceased. Soon the switch-board began to flash fire, and the work on the wires was hard. Between two and three o'clock we had a raging storm, with severe lightning and thunder. The fact was, I had received in the telephone intimations of the storm some considerable time before the relays were in the least affected.

Time has wrought changes. I no longer telegraph through the air, but am back again into more common pursuits. Mr. Dingle still follows the fortunes of the train telegraph, and is meeting with marked success on the Lehigh Valley Road. A special wire has been built there, and placed as near as safety will permit to the top of the cars. A strong margin is thus secured, and now the system is slowly fighting its way into notice, just as each of the other electrical improvements has done.

ON THE DIMENSIONS OF THE MAGNETIC QUANTITIES IN C.-G.-S. UNITS (ELECTRO-MAGNETIC MEASURE).*

BY M. E. HOSPITALIER.

The analogy between the electric and magnetic circuits has of late been very prominently brought forward. We propose, therefore, to take a rapid survey of the several magnetic quantities, and of their expression in terms of C.-G.-S. units, so as to lay the foundation for a more exact comparison between these and the correlated electrical quantities. We shall insist more particularly upon certain new definitions, and shall show reason for the abandonment of certain expressions which lead to equations of a non-homogenous character, and are manifestly inexact.

The point of departure of the magnetic system is the law of Coulomb, which serves to define the strength of a pole.

Strength of a Pole, or Quantity of Magnetism.—The force f between two poles, m and m', at distance d is given by the expression

$$f=\frac{m\,m'}{d^2}.$$

If m and m' have each unit value we obtain—

$$m=d\sqrt{f}=L^{\frac{3}{2}}\,M^{\frac{1}{2}}\,T^{-1}.$$

Magnetic Moment.—This is equal to the product of the strength of one of the poles by the distance between them. Calling this $\mathfrak{M}$ we have

$$\mathfrak{M}=m\,l=L^{\frac{5}{2}}\,M^{\frac{1}{2}}\,T^{-1}.$$

Intensity of Field.—When a pole, m, is placed in a magnetic field it is submitted to a force, f, proportional to the strength of the pole m, and to the intensity of the field H. We have then

$$f=m\,H,$$

whence

$$H=\frac{f}{m}=L^{-\frac{1}{2}}\,M^{\frac{1}{2}}\,T^{-1}.$$

The intensity of the field is then the *ratio* of a force to the strength of a pole.

* From *L'Electricien*, 12th November, 1887.

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Magnetic Flux (number of lines of force).—If we consider a uniform field of intensity, H, and of surface, S, in a plane perpendicular to the direction of the lines of force, the *magnetic flux* which traverses the section S is the product of the intensity of the field H by the surface S. Calling Φ this flux, we have

$$\Phi = HS = L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-1}.$$

It can be shown that the magnetic flux, or number of lines of force produced by an isolated pole of strength m, is equal to $4 \pi m$. We ought, therefore, to find the same dimensions for Φ as for m, which will be seen to be the case.

Intensity of Magnetisation.—By definition the intensity of magnetisation of a bar magnet is the ratio of its magnetic moment to its volume. Calling $\mathfrak{I}$ this intensity and V the volume,

$$\mathfrak{I} = \frac{m\,l}{V} = \frac{m}{S}.$$

where S is the section of the bar magnet (supposed uniform). Thus,

$$\mathfrak{I} = L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1}.$$

This quantity has, therefore, the same dimensions as the intensity of the field.

Magnetic Susceptibility.—A bar of magnetic substance, of indefinite length, placed in a magnetic field of uniform intensity H, acquires an intensity of magnetisation $\mathfrak{I}$.

The magnetic susceptibility is the ratio of the intensity of magnetisation of the bar to the strength of the field producing that magnetisation. This is usually denoted by K, then

$$K = \frac{\mathfrak{I}}{\mathfrak{H}}.$$

Magnetic Induction or Specific Induction. — An indefinitely long bar of magnetic substance, when placed in a uniform magnetic field of strength $\mathfrak{H}$, is traversed by a magnetic flux, Φ, greater than that which traversed the same space before the introduction of the bar. The flow of force through the bar is termed the *total induction*, and the mean strength of the field within the bar is called *magnetic induction* or *specific induction*, and is denoted by the letter $\mathfrak{B}$. Specific induction is homogeneous to intensity of field.

Magnetic Permeability.—The ratio of the specific induction of an indefinitely long bar to the intensity of the field which produces this specific induction is called the *magnetic permeability*, and is denoted by the letter μ.

$$\mu = \frac{\mathfrak{B}}{\mathfrak{H}}.$$

The permeability is simply a coefficient, and has no dimensions. It is proved that the following relation exists between magnetic permeability and susceptibility

$$\mu = 1 + 4 \pi K.$$

Magnetic Potential.—The magnetic potential at a point situated at a distance l from a pole m is the ratio of the strength of this pole to the distance l.

Calling this magnetic potential $\mathfrak{V}$.

$$\mathfrak{V} = \frac{m}{l} = L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1}.$$

The dimensions of the magnetic potential are those of a current intensity in the electro-magnetic system. This point will aid us much in understanding the magnetic circuit.

Magnetomotive Force. Magnetising Force.—A circuit through which a current is passing produces a magnetic field in the surrounding space. This field is easily defined in certain simple cases—for example, in that of an unlimited solenoid of indefinite length. If this solenoid is of uniform spiral and contains n turns of wire, then let its length be l, and let a current of strength C pass through it, the factor

$$4 \pi n C$$

is called the *magnetomotive force* of the solenoid, and the factor

$$\frac{4 \pi n C}{l}$$

its magnetising force.

It must be noticed that the magnetomotive force has the same dimensions as a magnetic potential or a strength of current $(L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1})$, whilst the magnetising force has the same dimensions as intensity of field $(L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1})$.

In the case of a solenoid the magnetising force is nothing else than the intensity of field within the solenoid.

The Magnetic Circuit.

We have been much led during the last few years to compare the magnetic with the electric circuit, and to find out the resemblances —by analogy—which the permanent or variable magnetic state of a magnetised medium has to the permanent or variable state of a circuit along which an electric current is passing. In certain particular cases, which we will touch on directly, the flow of force along the magnetic field is analogous to the current-strength, the magnetomotive force is the equivalent of the electromotive force, and the magnetic resistance takes the place of the electric resistance of the circuit.

In air and non-magnetic media, the analogy is perfect, and the calculations based on this analogy yield results which are in accord with those of experiment. In magnetic metals the resistance is a function not yet fully understood.

Magnetic Resistance.—Calling the magneto motive force in a magnetic circuit $\mathfrak{V}$, the flow of force produced Φ, and the magnetic resistance of the circuit $\mathfrak{R}$, the following relation is obtained:—

$$\Phi = \frac{\mathfrak{V}}{\mathfrak{R}},$$

whence

$$R = \frac{\mathfrak{V}}{\Phi} = L^{-1}.$$

The magnetic resistance in the electro-magnetic system is therefore expressed as the inverse of a length.*

Specific Magnetic Resistance.—Applying to the magnetic circuit the law of the electric circuit, we have evidently by analogy,

$$\mathfrak{R} = \rho \frac{l}{S},$$

ρ being the *specific magnetic resistance*,

whence

$$\rho = \frac{\mathfrak{R} S}{l}.$$

The specific magnetic resistance is therefore expressed as a number. It is a simple coefficient; in fact, the specific magnetic resistance ρ is the inverse of the permeability μ

$$\rho = \frac{1}{\mu}.$$

Permeability might therefore be called the specific magnetic conductivity or specific permeability.

In a recent paper "On the Theory of Dynamo Machines," Dr. Edward Hopkinson† asserts that the magnetic permeability is the inverse of the magnetic resistance. This is a mistake likely to occur in dealing with the equations of dimensions.

THE RECKENZAUN CAR IN PHILADELPHIA.

The following account of the latest type of electric tramcar designed by Mr. Reckenzaun is given in the *Philadelphia Ledger*:—

An exhibition of the new street car built for the Electric Car Company of America, and driven by electricity, was given yesterday. The new car differs in many particulars from the one with which the public are now comparatively familiar, although the principles on which it depends are the same. The source of power is electricity stored in accumulators or secondary batteries, and utilised by electric motors, which are geared to the axles. The car itself, however, is much larger than the ordinary street car and is believed to be the longest street railway car in the world. It measures overall 30ft., and its inside measurement is 22ft. It is mounted on two trucks, each having four wheels, and each truck bears an independent electric motor. Except for its size, the car does not differ in general appearance from the large cars used by the Traction Company. Its trucks, however, are constructed with steel frames, combining strength with lightness, and there are numerous other modifications. The body of the car is no higher above the wheels than the ordinary horse car, and none of the machinery is below the level of the axles except the gear wheel by which the power is applied to the axle. Under the seats of the car are arranged the storage batteries, 116 in number, and mounted on movable skids, so as to slide readily in and out of the car. On the back platform is a small square door, leading to the chamber which the charged batteries occupy, and opposite to it a hinged portion of the dasher, so that the whole collection of cells can be readily removed. When a car is to be recharged it is taken into the station and backed against a sort of double truck, arranged with wooden rollers, to receive the batteries. The door of the storage chamber being open, and the hinged portion of the dasher swung back, the exhausted battery and its supporting skid are withdrawn to one

* In the *Phil. Mag.* (May, 1883, page 310) Mr. R. H. M. Bosanquet finds that magnetic resistance is expressed as a length, and not as the reciprocal of a length. This error is produced by an incorrect definition of magnetic resistance—treating this resistance as the ratio of the magneto motive force to the magnetic induction, instead of treating it as the ratio of the magneto motive force to the flux [total number of lines of force].

† Read at the Manchester meeting of the British Association. See *The Electrician*, Sept. 9, 1887.

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side of the truck. The truck is then moved sideways until the other half is in line with the car. On this is arranged a freshly charged battery which is slid into the place of the old one, and the car is ready to start on its journey. The exhausted battery is then conveyed to the dynamo on the truck, in order that it may be re-charged. Charging a car occupies a very few minutes' time, and when charged it is expected to run from four to six hours without recharging. The electric motors are situated beneath the floor of the car, one being borne on each truck.

They are of the Reckenzaun type. They are very compact, and are mounted above the axles of the wheel in line with the longitudinal axis of the car. The shaft of the motor has a worm gearing on its extremity which gears with a spur wheel on the axle of the car, which is, of course, at right angles with the motor. The Reckenzaun motor used is remarkably compact, forming an almost perfect cube about 18in. on the side, and developing nominally eight horse-power, although the inventor states it will readily work up to fifteen horse-power.

The mechanical brake on the car is new and appears to be very effective. An iron lever actuates through a series of levers a strong toggle joint, which causes two iron shoes to block the adjacent wheels of each truck.

The switch for governing the current, the alarm gong, electric light and electric signal to the switchman do not differ from those already described on the other car. Each of these devices is supplied with a shunt current from the battery and is under perfect control of the conductor or switchman.

The exhibition yesterday was very successful, the car rounding very sharp curves and surmounting grades in the yard of the company with the greatest ease, the perfect control of the movements of the car for starting, stopping quickly, and reversing being specially noticeable. It was stated that at a recent trial a single charging had been sufficient for a forty-five mile run, and that in one hour's run about the yard of the company the car had covered twelve miles. A street trip through the city was made on the old single-motor car, over the Chestnut and Walnut-street tracks. Among the passengers were Mr. Whitney, President of the Boston Consolidated Street Railways; Mr. H. H. Derr, of the Wilkesbarre and Suburban Lines; and Messrs. Widener and Elkins, of the Philadelphia Traction Company.

The Electric Car Company are now putting up large shops at Twenty-second-street and Washington-avenue, for the manufacture of electric machinery for street cars. The cars themselves will not be manufactured, but the storage batteries, motor gearing and appliances will be adapted to them. The company propose building not only the apparatus for cars driven by a storage battery, but also other forms, with overhead conductors and similar systems. It is expected that they will be fully under way by the first of the year.

THE ELECTRIC LIGHT AT THE ROCK MILL, LONDONDERRY.

[A COMMUNICATION.]

Mr. W. Shannon, of Waterloo-place, and local representative of the Gülcher Electric Light and Power Company (Limited), Battersea Foundry, London, S.W., has just completed an installation of the electric light at the Rock Mills of Mr. G. K. Gilliland, J.P.

The installation consists of a Gülcher low-tension dynamo, upwards of 80 incandescent lamps of 20 candle-power, and one arc lamp of 2,000 candle-power, which is suspended by a block and fall arrangement from a very neat pole placed in the centre of the yard of the mill. The dynamo is placed on the stone loft on a sliding bed, which is bolted to a wall about 3ft. in breadth, and is capable of running 150 incandescent lamps of 20 candle-power, and delivering 14 horse-power in electrical energy at its terminals. It runs at a speed of 860 revolutions per minute, and is driven by a steam engine which is also used for driving the machinery of the mill. The machines are surrounded by a dust-proof partition. Every safeguard has been taken against any possible chance of fire, and the installation has been put up under the Phœnix Office fire rules. There is not only a safety fuse on the main switch, but one on every subsidiary switch and on every lamp.

The lamps are suspended by silk flexible cords from ebony ceiling plates, which contain safety fuses, and are perfectly dust-proof, each pendant consisting also of a dust-proof ebony holder and a 6in. opal shade.

Lamps with flexible leads are used for placing inside some of the machines to see that the silks are working satisfactorily. The current is led from a switch-board in the dynamo room by a main cable, which supplies branch cables to each floor of the mill, offices, carpenter's shop, and stables.

In each case where the cables pass from the old to the new mill they are run in earthenware pipes lined with asbestos, which is absolutely fireproof. There is a switch to every circuit and to every two lamps.

Whatever may be the sanitary or incidental advantages of electric lighting, there is one essential condition of its adoption, viz., it must benefit the pocket of the user. The advantage comes sometimes, not merely in the bare comparison with the gas bill, but in the longer hours and better work, or reduced fire risk.

The lighting of corn mills differs somewhat from other mills; first from the crowded position of the machinery, elevators, belts, and from the inflammable nature of the machinery and of the flour itself in all its stages. We know well the explosive character of an atmosphere laden with flour dust, and the condition in all the elevators and purifiers—and, indeed, all parts of a roller mill—is such as to make an ever-present caution not merely desirable but essential in this respect. The incandescent lamp may certainly be said to provide a security from dust explosion not attainable where gas is used. A sack of flour falling downstairs opens, perhaps; the contents are scattered, and where gas is used the dust catches fire, the windows are broken, and possibly part of the building lifted. A few minutes a day is sufficient for keeping everything in order, and millowners who have power to spare in their mills will find that they will benefit themselves in every way by the adoption of this, the light of the future. The whole arrangements were carried out by Mr. A. J. Baron, of the Gülcher Electric Light Company. While on this subject we may state that Mr. Gilliland has entrusted Messrs. Victor, Coates and Co., of Belfast, with an order to erect a new engine of 200 horse-power at the mill. The engine is to be designed specially with a view to giving steadiness to the electric lights.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Dec. 8th*, 1887.

It has been a habit, almost a settled custom, with European visitors in this country to write a book of 300 or 400 pages on it after spending perhaps a month within its borders. What these books lack in accuracy they often make up in piquancy, and that piquancy is derived not so much from the descriptive talent or keen powers of observation displayed by the writer as from the readiness with which amusing newspaper stories are seized upon and treated as if the eccentricities therein brought to light were fairly representative of the life of fifty millions of people. An incident that ought to figure in all such books is just recorded from Washington. It appears that a Congress man from one of the back districts of Texas, on arriving at Washington to perform his legislative duties this winter, proceeded to one of the leading hotels, and on going to bed carefully blew the gas out. Some time thereafter the odour of escaping gas gave warning, and the unfortunate backwoodsman was rescued by the servants. Of course, this should argue on the part of Congress men in general a sweet simplicity of manners, and it will not be surprising to see the episode related in some new book of travel as typical of social life in Washington. The story is certainly amusing, and yet it is safe to say that in many parts of Texas, perhaps even in the regions from which this unsophisticated law maker hails, the electric light has obtained a greater application even than in scores of places 25 miles from London. Thus such a city as Austin, Texas, has a plant that may safely challenge comparison with any other for completeness of detail. The station is a handsome brick building, 90ft. by 40ft., and the plant includes both arc and incandescent systems. There are 75 miles of circuits, and that the company is well abreast of the times is seen in the fact that it has already over 600 lamps in operation on the Westinghouse alternating system. Yet Austin is no exception, for as much might be said of Galveston, Dallas, Palestine, Fort Worth, Houston, and other places in the Lone Star State.

Speaking of Congress men reminds one that, though the subject of Government telegraphs promised to occupy no small share of attention at Washington this winter, there is a possibility that it may be relegated to a second or third rank in public estimation, as a vital issue, by the pronounced stand just taken in the address of President Cleveland to Congress advocating reduction of the taxes. It is shown in this address that in spite of all National Debt redemption the surplus in the Treasury next June is likely to reach £28,000,000 sterling, and obviously something must be done to lessen the burden of the people, and to release this money for legitimate circulation. While the President disclaims any distinctively Free Trade sentiments, he is careful to point out that the revenue can be reduced only by lowering the Protection tariff, and he

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forces this matter on the attention of the country in a very able manner. Thus the question of Protection and Free Trade has already become a leading topic of the next Presidential campaign, and it seems likely that postal telegraphs may for a while lose their interest. It is likely that a new Tariff Bill will shortly be introduced in Congress, and that it will in various ways affect the numerous electrical industries ; but at present it is premature to speculate in that direction.

Without waiting for the action of the Government one way or the other, the new opposition telegraph company springs to its feet and salutes the great American Republic with the familiar statement that it intends to fight the great monopoly, and will never sell out. The new concern is to be known as the Postal Automatic Telegraph Company, and one of the prime movers is Mr. Chester Snow, who is already well known in such matters. It is proposed to secure for this company a charter in Massachusetts of liberal scope, and to start with a capital of £600,000, which may be increased at a later date to £4,000,000. The plan of the company, is to operate from New York to San Francisco, &c., and to put up light poles and copper wires throughout, using also new automatic systems. Should the company be in earnest—and perhaps it is not fair to believe otherwise—there is plenty of ability and material at its command for the development of its system, and there is unquestionably a very strong sentiment in favour of competition. By-and-bye, when the company has shown its hand more, it will be easy to judge how far it is deserving of sympathy and support.

The delay in the United States Supreme Court in rendering a decision on the Bell patent is giving no small amount of anxiety in various ways, but cannot be said to have affected the stability of the stock of the American Bell Telephone Company. Some of the "opposition" stocks are being boomed, and even on the most favourable consideration their prices are simply ridiculous. In all probability the rendering of a verdict adverse to Prof. Bell would bring these stocks down much nearer their actual value, whatever that may be. One of the grounds for hopefulness of those who would like to enter the telephone business untrammelled by the Bell patent is that the Supreme Court has of late evinced a tendency to limit the scope of patents and lessen the extent of the protection they may afford. On the other side, it is pointed out that even should the Bell patent be limited, or even thrown out, the Bell Company controls at least 300 or 400 other patents, has an intimate acquaintance with the business, a vast amount of capital, and a system co-extensive with the country, and that as telephone service is naturally a monopoly, in the sense that there can only be one good exchange service in each place, the company is likely to hold all that it now enjoys.

An interesting little telephonic development in Nova Scotia deserves notice. Telephonic service was recently undertaken in that province by an organisation operating the Law system. The company has made such progress that it has already succeeded in buying out the Old Bell Company there, and is to-day practically master of the situation. This has been done chiefly through the exertions of Mr. A. A. Knudson, an electrical engineer of this city, who has also succeeded in giving a stimulus to a variety of electrical applications in Nova Scotia. It is, perhaps, a little singular that this work should have been left to an American to perform, although Halifax is conveniently reached from either New York or Boston. It is understood that large quantities of electrical supplies are now being regularly forwarded to the province. American electrical manufacturers find there a good market for their productions.

The Westinghouse alternating system of electric lighting appears to be making continuous headway, and at the annual meeting of the stockholders just held at Pittsburg, it was stated that the company was earning dividends at the rate of 10 per cent. on its capital of £1,000,000. The greatest interest is being taken in all questions relating to alternating currents, and the meeting of the American Institute of Electrical Engineers held in this city on December 6th, when Mr. Wm. Stanley, jun, electrician of the Westinghouse Company, read a paper on the "Phenomena of Retardation in the Induction Coil," was probably the best and most lively of the season. Mr. Stanley presented a brief and able paper, which provoked an active discussion, lasting far beyond the usual hour.

It was mentioned last week that extensive preparations were being made to supply incandescent lighting in the upper districts of this city. Meantime work is going on actively to extend the arc lighting service, and the new East River Company, which is to operate the Thomson-Houston system, has secured an enormous seven-story building for its station near the East River and Twenty-fourth Street. It is interesting to note that in this building was temporarily placed the plant with which the experiments were made on the elevated railroad with the Sprague and the Field systems of electrical locomotion. The building has thus already an electrical history, and is likely soon to be known as the largest electric arc-light station in the world.

Electrical development in this country is attended by costly and never-ending litigation. At the present time the long list of suits pending has been added to by an action brought at Detroit, in the Brush interest, to protect the Brush arc lamp from alleged infringement by the Fort Wayne Jenney Company, and by the suit brought at Baltimore by the Consolidated Electric Light Company, controlling the Sawyer-Man patents, against the local Edison Company of Cumberland, Ma., for the infringement of incandescent lamp patents. Another movement involving litigation is that set on foot by various carbon point manufacturers, who met recently at Cleveland, and decided to sustain one of their number in a suit which the Brush Company has brought to prevent the manufacture of copper-coated carbons, in regard to which it claims exclusive rights.

CORRESPONDENCE.

THE *CONVERSAZIONE* OF THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I am instructed by the President, Sir Charles Bright, to request the favour of your permitting him to express, through your columns, his great regret that so many of those gentlemen who favoured Lady Bright and him with their company at the reception at the Institute of Painters on Thursday evening last should have experienced so much inconvenience by the unfortunate break down of the arrangements in the cloak room.

The space available for the deposit of hats and coats is certainly very limited at the Institute, but the accommodation provided and the number of men engaged was the same as upon the occasion of Prof. Hughes' *conversazione* held at the same place last year, and as no confusion then occurred there was no reason to anticipate any last Thursday.

Mr. Hart, the resident porter and door keeper at the Institute, who had, as before, the immediate charge of the arrangements, attributes the occurrence to the circumstance that so very large a number of visitors arrived almost simultaneously at one period of the evening, that it was practically impossible for him and his assistants to deposit the coats and hats in their proper numerical order. This of course led to some delay in giving the coats and hats out, and some of the more (not unnaturally) impatient visitors then insisted on going behind the barriers to find their coats themselves. From that moment confusion reigned. I myself hastened on the scene immediately I was informed of what was occurring, and endeavoured, with only partial success, to persuade those gentlemen who had forced their way inside the barriers to retire and leave the attendants to perform their duty as well as the state of things would permit.—Yours, &c.,

F. H. WEBB, Secretary,
Society of Telegraph-Engineers and Electricians.
London, December 21st, 1887.

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THE HORNSBY ENGINES AT THE AMERICAN EXHIBITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having seen the paragraph in your issue of November 11th, headed "Notes on the Electric Lighting of the recent American Exhibition," we beg the favour of space for a few words in reply, as several of the statements made are far from accurate.

The writer of the paragraph falls into a mistake when he says the buildings and grounds were lighted from seven 50-light dynamos and two 35-light machines driven by three of our engines, with an aggregate of 90 indicated horse-power.

Four of our engines drove the dynamos, none of which were 50-light ones, and the indicated horse-power was 348, and not 90, as stated.

The following are the particulars:—

One Engine each of

Nominal horse-power.	Type.	Indicated horse-power.	Dynamos driven.	Number of arc lights.
10	Compound	35	1	30
30	do.	69	2	61
50	do.	107	2	71
60	do.	137	2	80
		=348		

More important to us, however, is the implication running through the whole that several unsatisfactory features were shown in this installation, and that every mishap rested with us, although it is admitted that "the installation was carried out under considerable difficulties;" and yet that from the trial run until the closing of the Exhibition "the lighting was carried out in the most satisfactory manner."

It appears to us to have been the intention of the writer to unfairly praise the electricians at the expense of those who shared with them both the difficulties and the success.

For instance, reference is made to the "delay in getting the shed ready for the reception of the dynamos," but it should also be known that this shed was engine house also, so that we were even more affected than the electricians. This shed was not ready for the reception of our engines until April 27th, and we had, therefore, the short time of nine days in which to fix them; and even then the roof was not completed for three weeks after we had started running.

The shed itself was thoroughly unsuited for the purpose, and the engines might almost as well have been in the open air. They were fixed between two constantly opened doors, and the shed was so full of dust and grit as to cause the bearings, not only of the engines and shafting, but also of the dynamos to frequently run hot and need cooling.

It is, however, incorrect to say that "as many as three pumps were at work throwing water on the bearings to keep down their heating," as there was never more than one hand pump in the shed at any time.

The electricians must know that this heating was beyond either their or our control, resulting from the cause we have mentioned, as they not only put canvas round the eaves to try and keep out the dust, but also had to use ice freely almost every night on the dynamos to keep them running.

They, as well as ourselves, frequently complained to the Exhibition authorities of the state of the shed, but obtained no assistance until July, and we have seen several men attending to one dynamo whilst it was being run dead slow to cool it down.

This explanation will also account for what is described as "the general state of the engine room (which was also the dynamo room, as already stated) as regards cleanliness."

We admit that it did not "excite our admiration" or that of those in charge of the dynamos; but, we believe, all did the best they could under most unfavourable conditions.

We may also mention that the foundations supplied by the Exhibition authorities both to us and the electricians were constantly sinking.

We need only trouble you upon one other point. The only breakdown during the whole time of the Exhibition is described by your article as "caused by a tube being blown out of one of the boilers." No such thing happened at all to any of the boilers, but on one occasion (and we presume this is the occasion referred to) a plug was fused owing to our running the engine dead slow to suit the electricians, who found one of the dynamo bearings running hot. Running at such a slow speed the engine pump failed to keep up the water supply, and hence the fusing of the plug.

We need not enter into any detailed defence of our engines, which are well known as having been successfully employed in some of the largest installations, but perhaps the best answer to your correspondent's remarks is the mention of the fact that Mr. Bryson, the eminent and successful electrical engineer of the Manchester Exhibition, who has been appointed to the same office at the Glasgow Exhibition, has, after six months' experience with our engines at Manchester, pressingly invited us to send our engines to Glasgow also.

The following letter from the general manager of the Manchester Exhibition will serve to confirm his judgment, and show that where the conditions are ordinarily satisfactory, our engines do win approval and fully satisfy even those most competent to judge of their performance:—

"Manchester, 1st Dec., 1887.

"Messrs. Hornsby and Sons (Limited),
"Spittlegate Iron Works, Grantham.

"Gentlemen: In reply to your favour of the 24th ult. I have much pleasure in testifying to the admirable manner in which the driving of the dynamos throughout the whole period of the Exhibition was done by your engines.

"I have referred to the log book, and find only four trifling entries against them.

"The run has been exceedingly successful throughout, and I think I am correct in stating that we have never once, since the lights commenced, had a failure in any part of the Exhibition.

"It gives me very great pleasure to testify to this effect, and I shall always be glad to recommend your engines for similar service in future.

"I am, Gentlemen, yours faithfully,
"(Signed) Samuel Lee Bapty,
"General Manager."

With thanks for the space afforded us.—Yours, &c.,

RICHARD HORNSBY AND SONS (LIMITED).

Spittlegate Iron Works, Grantham, December 20th, 1887.

[In justice to ourselves we think it right to add that the paragraph in question reached us from an outside source, though one in no way connected with either engine or dynamo manufacture. The above letter was written in reply to a request from us that Messrs. Hornsby and Sons would correct the inaccuracies for which we had inadvertently become responsible.—ED. *E.*]

PRIMARY BATTERIES FOR HOUSE LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I must ask your indulgence in briefly replying to Mr. Ross's criticisms on mine of the 6th inst.

Mr. Ross's objection to my estimate of battery fuel cost as taken from Mr. Nursey's paper is peculiar. He prefers that I should have based it on horse-power inferred from the lamp hours rather than on the horse-power given. Mr. Ross fails to see that there are possible reasons for the apparent discrepancy he notices. Batteries of the size in question are not run to exhaustion without a gradual falling off in current, and 10 candle-power lamps are not unfrequently 5 candle-power worked to give 10 candle-power.

The figures representing the cost of fuel for battery in my table were simply taken as given. I claim no responsibility for them; they may be right or wrong; but to have based them on such unstable and uncertain ground as lamp-hours would have been inviting error.

It seems a pity that this vexed question could not have been once and for all set at rest by a public test such as has been suggested in your columns.

The other points raised in Mr. Ross's letter may be disposed of by the simple fact that any increase in the fuel costs for small engines, either by decreased efficiency of the system or

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larger consumption of coal, would not materially alter the total. This will be evident on referring to the table in question, where it will be seen that the cost of fuel only ranges from 7 to 15 per cent. of that apportioned to labour. I should have had much pleasure in meeting Mr. Ross's objections on their own merits, but I do not consider myself justified in prolonging this discussion on side issues.—Yours, &c., N. G. THOMPSON.

4, Queen Victoria-street. London, E.C.,
December 21st, 1887.

ELECTROLYSIS OF PERSALTS OF IRON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Alexander Watt has been good enough to call attention, on page 135 of *The Electrician* of Dec. 16, to a statement of mine on page 245 of my little book on the "Art of Electro-Metallurgy," in which I say "solutions of persalts of iron yield no metallic deposit, but are reduced to protosalts by the passage of an electric current through them." He then remarks, "That this statement is not correct I will now endeavour to prove," and he proceeds to describe his experiments.

In his first article, of Nov. 11, he says :—"*Perchloride of Iron.* A solution of this salt does not yield a deposit of iron." "*Persulphate of Iron.* This salt also yields no deposit of iron by electrolysis." In his second, of Nov. 27, he commences by repeating these statements; but in the next paragraph he states that he separated iron from a solution of "pernitrate of iron" as "a thick black deposit, interspersed with bubbles of hydrogen, which rested firmly on the plate. Surrounding these gas bubbles were minute glistening particles of metallic iron, which had evidently been reduced by the hydrogen," and "the evolution of gas was much more copious with the weaker than with the stronger solutions."

In his third article of the 16th inst., after describing experiments in which he used solutions of "persalts of iron," and obtained deposits of iron upon the cathode, he concludes that he had "thus proved that iron *can* be deposited from solutions of its persalts when the proper conditions have been arrived at;" but he does not state the essential conditions.

As Mr. Watt has done me the service of criticising my statement, and has publicly asserted that it "is not correct," I beg leave to give the following evidence in support of it:—

When an electric current passes from a solution of a persalt of iron into a cathode its immediate effect is to separate hydrogen, which at first does not appear, but is absorbed in reducing the layer of particles of persalt next the cathode to protosalt by uniting with some of their oxygen or chlorine; and its next effect is to decompose the protosalt thus formed and separate its metal. So that the metallic deposit obtained by Mr. Watt was not yielded by persalt, but by protosalt. When there is but little persalt present, less of the hydrogen is absorbed and more evolved, and this agrees with Mr. Watt's observation "that the evolution of gas was much more copious with the weaker than with the stronger solutions."

Several electro-metallurgists have observed the production of protosalt, the deficiency of metallic deposit, and the waste of current in a depositing solution containing persalt of iron. Badia states (*Scientific American* Supplement, No. 478, p. 7,634) that in one of persulphate of iron "protosulphate comes from the reduction of ferric sulphate when the latter is near the cathode; that this requires an expenditure of energy, and that if we prevent contact of the persulphate with the cathode there will be no longer any reduction." "In order to obtain proof that the ferric sulphate at the cathode absorbs electric work," he made and describes a chemical experiment showing the production of ferrous sulphate; it may, however, be shown in a simpler way, viz., by change of colour of the solution.

That the persalt must be reduced to protosalt before it is further reduced to iron is proved by thermo-chemical data, *i.e.*, by the different amounts of heat required to produce reduction in the two cases; thus, whilst it requires 96,040 centigrade gramme calories to separate a molecular weight in grammes of $FeCl^3$ into Fe and Cl^3, and 82,050 to separate one of $FeCl^2$ into Fe and Cl^2, it only requires the difference between these, viz., 13,990 such calories, to reduce one such weight of $FeCl^3$ to $FeCl^2 + Cl$. It therefore only consumes about one-seventh the amount of energy to reduce the persalt to protosalt that it takes to reduce it to metal, and that is the fundamental reason why it is reduced to protosalt first.

The essential reason why Mr. Watt obtained contradictory results in different experiments was probably difference of density of current at the cathode. He has offered no proof that protosalt was not produced or present in his experiments when he obtained a deposit of iron; if he will suitably test the liquid at the cathode during electrolysis he will probably find some there.—Yours, &c., GEORGE GORE.

DR. SHETTLE'S EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I must ask you to be good enough to find me space in *The Electrician* for a few remarks in reply to your comments upon the paper which I read at the Physical Society on December 10.

In the first place, that paper contained no allusion to the "supposed new force" of M. Thoré.

By reference to *The Electrician* of August 19th you will perceive that my investigations were conducted with a view to show the connection between gravitation and magnetism. In my paper at the Physical Society I included the correlation of physical forces generally, and it is only in so far as M. Thoré's experiments come within the limits of these forces that my investigations have any connection with his "supposed new force."

In the second place, in spite of your kind remarks as to the way in which my experiments have been conducted, I feel compelled to point out an error in your criticisms. You say, "The whole argument can be put in a nutshell. Dr. Shettle takes a sphere of some insulating material, he winds it round with copper wire, and suspends it very delicately in front of the pole of an electro-magnet. In different experiments the winding is done in various and elaborate forms, but—and here lies the whole secret—*the ends of the wire are always joined so as to form a closed circuit.*"

If I add a few particulars as to the mode in which the wire was laid on to the spheroid mentioned in *The Electrician* of August 19th you will perceive that if there was any connection between the free ends of the strands of wire it was an accident, which, in the laying on of so many strands, could not perhaps be well prevented; but it must have been very exceptional. The large spheroid of 1,000 yards of wire, and containing upwards of 2,000 strands, was constructed with the object of testing how far currents of electricity and polar phenomena could be induced by magnetism in a spheroidal mass composed of a large number of strands of copper wire, each of which had free terminals. These terminals were all carried to four points corresponding to the terrestrial magnetic poles. These strands of wire were carried once and a half round each hemisphere and then cut off short, *care being taken not to remove the silk covering*; they were then fixed down at the proper sites with *india rubber* insulite, and as each wire stopped a little short of its predecessor, it is difficult to perceive how the free ends could have come into contact, and my belief is that they were insulated in almost if not in every case. This sphere, when properly suspended and acted upon by a magnet, behaved like an ordinary compass needle.

But I was not content with this, and commenced to reduce the thing to its greatest simplicity. I therefore made others, of which I will fully describe one. This consisted of a central sphere between two hemispheres, and was covered with three layers of wire. The first layer commenced on one side of one of the hemispheres, and after being wound closely over every portion of the surfaces terminated at a corresponding point on the other hemisphere. The spheroid was then suspended in the magnetic field, and exhibited polarity at the terminals of the wires. A second layer of wire was then wound on in the same way as the first, the terminals being ⅓rd of the circumference of the hemisphere away from the terminals of the first layer. The effect of the magnet was then again tested, and now the

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pole was situated midway between the two terminals. A third layer, with its terminals ⅓rd of the circumference from each of the others rendered the polarity more confused; but motion was established at any point when the body was suspended vertically in the magnetic field.

In this case there could be no possibility of contact between the terminals of the wires, and of closed circuits being formed.

Having thus far tested the influence of the magnet upon wires with free ends, I covered wooden spheres with *insu*lated and *un*insulated copper wire, the strands being as close together as possible, and purposely converted these into closed circuits. These were tested in the magnetic field, and elicited phenomena in both cases similar to those shown by the other spheres; but the motion was greater, and especially in the case of the *un*insulated wire.

I next tested some wire helices, the strands of which were quite separate and the terminals free. These were made for me, with great exactitude in the winding and in the situation of the terminals, by Messrs. Elliott. These were wound round wooden cylinders, and when suspended exhibited rotation and polar phenomena just as the spheroids had done. Other helices of wire were made, of which the terminals were joined by passing a connecting wire through the centre of the core. When suspended in the usual way no difference could be detected in the degree of motion.

Subsequently I tested solid copper and zinc spheres, and as the phenomena exhibited tallied remarkably with those shown by the wire spheroid, I arrived at the conclusion that currents were generated in them also by the influence of the magnet, and that these currents took a definite direction from some irregularity of density in the metal.

You will thus perceive that I have tested and counter-tested the influence of the magnet upon closed circuits and upon helices with free ends, and therefore I think you will admit that my experiments are not to be explained upon the hypothesis which you have suggested. My own opinion is that these experiments show that magnetism is due in all cases to current energy.—Yours, &c., RICHD. C. SHETTLE, M.D.

[It is, we think, clear from Dr. Shettle's letter that the explanation which we offered last week does not cover the case in which the circuits were absolutely open. We hasten, therefore, to acknowledge that this experiment is of higher intrinsic value than we were inclined to suppose. At the same time we have no doubt that our first explanation is correct so far as the assumed condition is fulfilled.—ED. *E.*]

TRADE CATALOGUES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Seeing in the last issue of your contemporary, the *Electrical Review*, a note with regard to the unscrupulous piracy of trade catalogues by those wishing to profit by the work of other people's brains, we shall feel greatly obliged if you will allow us to make a few remarks, lest, as it is pertinently stated, we may be judged to be copyists, when, as a matter of fact, we have been victimised just in the manner described in that note.

Four years ago we published a catalogue, succeeded a few months since by a new edition, in which edition a great deal of the same matter appears again, and some in a precisely similar form as before. It has come to our knowledge that this old catalogue which we omitted to register has been largely copied by a firm who have not scrupled to cut out page after page, sending them to their printer to be set up as original matter, embodying them into their own catalogue. Our new edition, which we have taken the precaution to register, was issued a few months before the above-mentioned copy, and it seems to us that the matter extracted is as much taken from the registered as from the unregistered edition.

It would be interesting to know how far a printer is culpable when he is aware that he is setting up matter which has been taken from another catalogue which he himself may or may not have actually printed.

We do not desire to trespass further on your space, and should not have troubled you with these few remarks but for the reason before stated, that we wish to avoid being considered mere copyists, incapable of compiling an original catalogue.—Yours, &c., KING, MENDHAM AND CO.

Western Electrical Works, Bristol, December 20, 1887.

THE LIGHTING OF WELLINGTON, NEW ZEALAND.

At a meeting of the Wellington (New Zealand) City Council the following report was presented by the Mayor on the question of lighting the city by electricity:—"In fulfilment of a promise made to the Council in connection with the electric lighting of the city, I recently visited Reefton with a view of gathering such information as might assist us in coming to a decision. The installation at Reefton is not yet in work; it is principally for domestic lighting of houses and business places. The Swan incandescent lamp is adopted. The scheme is a private speculation of a company with a capital of £5,000. The motive power is water supplied through a 50 horse-power turbine, the cost of bringing the race is about £2,300, the light is supplied by a single dynamo of 520 candle-power, the cost of dynamo and turbine with wires laid on to houses is about £1,800. It had been intended to lay the wires in the main street underground, and in other streets to carry on poles, but it is probable that the whole wires will be carried on poles, as it is considered less liable to injury than if laid underground. Private consumers have to provide their own fittings, the company charging for supplying the light for each lamp of 20 candle-power the sum of £2 per annum, the man being at liberty to use it from dark to daylight. In order to be able to see if the above information will be applicable to Wellington, there are three points to be considered. The first is—Can water be given for motive power? Second, Is water-power the best motive, all things considered? The third point is, Is the estimate of £2 per annum for 20 candle-power lamps reliable? To the first it may be pointed out that we have a large amount of water running to waste, for although there was some scarcity of water last summer, it was not from lack of water, but from leakage, which is now being repaired. Even then there was a supply of 98,000,000 gallons in Karrori, which will be available with the more high-level pipes which are now being laid. Even when water was short it must be remembered that the consumption was over 100 gallons per head, which is about five times the amount consumed in English towns, where there is a proper system of waste prevention. The water would be drawn off at night when little or no consumption would be going on; and it must be remembered that when the greatest amount of light would be required would be in winter, when both reservoirs are flowing over. Furthermore, if required, it is known that the Wainui supply can be doubled at not a great cost; and, further, the fact that the water supply has cost £215,000 shows it is of the utmost importance to make the best use of it. The above is, I think, sufficient to show that there is no difficulty as to water supply for power. The next question for consideration is whether £2 per annum per 20 candle-power is reliable. I am able to test this from other sources. At Broomhill, in England—where one of the most complete plants in the kingdom has been laid down, costing for engine, boilers, dynamo, batteries, buildings, &c., £6,000—accurate accounts have been kept for several years of every penny spent on the light. They have brought the electric light down to one-seventh 1d. per hour for 20 candle-power lamp. A six-foot gas burner costs ½d. per hour with gas at 3s. 6d. per 1,000, the electric light thus proving nearly twice as cheap as gas at 3s. 6d. per 1,000. It is expected to be brought further down still to one-tenth of a 1d. per hour. I am informed by an engineer who was engaged in fitting up Taunton, in England, that the charge is for a 1,200 candle-power arc light 2d. per hour, and incandescent lamp, 20 candle-power, £1 per annum. To sum up, a 20 candle-power lamp would cost Reefton £2 per annum; Broomhill, £1 1s. 8d.; Taunton, £1. In each case wear and tear and profit are included. In Wellington, according to the Corporation books, the mean of 40-meter lamp shows that it costs for gas alone £3. 17s. 9d., but if we add breakage, wear and tear, the cost is £6. 10s. each lamp. In 1872 it cost to light Brooklyn £145,000, with a population of 400,000. In 1887 the cost by electricity is £85,000, although the population increased to 700,000. From what has been stated it is fair, I think, to conclude that by using our resources we can thoroughly light the city from end to end without extra annual charge. All will agree that the city is badly lighted, taking all its surroundings into consideration, especially when we consider that sometimes from Saturday night to Monday over 400 persons arrive by sea. Our shortness of funds compels us to spend less on lighting than any other city in New Zealand, as the following will show:—Auckland, £2,112; Christchurch, £2,600; Dunedin, £2,730; Wellington, £1,650. To light the city fairly would take at least 300 lamps, and to give, say, two hours more of gaslight than we have now would cost at our present rates per lamp £2,650 per annum. By using water-power in the manner I have indicated to light the city by electricity, I estimate the same amount of light can be got at an annual charge of about £1,650, thus saving about £1,000. The success of lighting the city will partly, if not wholly, depend on the proper working out of the details and choice of motor; and I might add that Dr. Lemon has kindly promised his valuable advice and assistance in carrying out the matter."

Councillor RICHARDSON moved that the report be accepted. The thanks of the Council, he said, were greatly due to the Mayor for the trouble he had taken.

Councillor EDWARDS seconded the motion, which was carried.

The matter was subsequently referred to a committee, consisting of the Mayor and Councillors Brandon, Richardson, Williams, and Edwards, to collect information and report to the Council.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

17,298. E. H. SUGGATE. Middlesex. An electro-pneumatic action. December 16.

17,320. C. AUTY. London. Improvement in apparatus for lighting incandescent lamps. December 16.

17,409. C. A. McEVOY. Surrey. Improvement in electrical primers or fuses. December 17.

17,457. H. E. M. D. C. UPTON. London. An improvement in electric safety lamps. December 19.

17,415. J. G. LORRAIN. Measuring and recording apparatus. December 17.

17,502. G. HOOKHAM. Electricity meters, dynamo-electric generators and motors. December 20.

17,508. F. L. RAWSON and WHITE. Electrical switches. December 20.

17,548. M. SETTLE. Magneto-electric machines for firing explosive charges for mining, &c. December 21.

17,585. M. BENARDOS. Electric regulators. December 21.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

December 17, 1887.

13,660. SIR D. L. SALOMONS, O. E. WOODHOUSE, and F. L. RAWSON. London. An improved combination electrical switch. October 25, 1886.

17,018. M. H. SMITH. Halifax. Improvements in appliances for transmitting electric currents in electric rail or tramway systems. December 29, 1886.

15,653. H. H. LAKE. London. Improvements relating to electrical apparatus for signalling in railway trains and to coupling devices for use therewith. (The De Mier Electrical Train Signal Company, United States.) November 15.

15,730. J. VAUGHAN-SHERRIN. Kent. Improvements in galvanic batteries. November 16.

December 21, 1887.

16,661. R. P. SELLON, W. M. MORDEY, and C. E. WEBBER. London. Improvements in self-regulating dynamo-electric generators. December 18, 1886.

266. E. EDWARDS. London. Improvements in electric telegraphs. (D. Kunhardt, Germany). January 7, 1887.

PATENTS SEALED.

December 13, 1887.

12,778. S. F. WALKER. Glamorgan. Improvements in dynamo electric machinery. October 7th, 1886.

14,286. A. WUNDERLICH and O. EISELE. Belgium. A new or improved galvanic battery. November 5th, 1886.

7,975. L. C. E. LEBIEZ. Paris. Improvements in secondary batteries or accumulators. June 2nd, 1887.

9,645. F. MARTENOT. France. Improvements in the method of and apparatus for applying electricity to steam and other boilers, compressed air machines and gas meters for the prevention of explosions, and also for automatically supplying the feed water to boilers. July 8th, 1887.

—— A. SMITH. Manchester. Improvements in the construction of holders for incandescent lamps. August 19th, 1887.

12,019. H. HARTIG. Germany. Improvements in electromagnetic motors. September 5th, 1887.

December 16, 1887.

16,201. R. DICK and R. KENNEDY. Glasgow. Improvements in and relating to the transformation and distribution of electric energy and appliances therefor. December 10th, 1886.

16,326. R. DICK and R. KENNEDY. Glasgow. Improvements in and relating to the transformation and distribution of electric energy. December 13th, 1886.

[3,811. T. R. WESTON. London. A new method for obtaining electricity on vehicles. March 14th, 1887.

9,104. A. P. TROTTER and H. W. RAVENSHAW (Yorks.), and W. T. GOOLDEN. Improvements in dynamo-electric generators and motors. June 27th, 1887.

SPECIFICATIONS PUBLISHED DURING THE MONTH.

275, 1887.—R. E. B. CROMPTON and J. H. F. SOLL. Distributing currents of electricity. (Price 8d.)

1,331, 1887.—D. HALPIN and J. A. TIMMIS. Commutator brushes for electrical apparatus. (Price 8d.)

COMPANIES' MEETINGS.

The Gulcher Electric Light and Power Company, Limited (in Liquidation).

Pursuant to the order of the Honourable Mr. Justice Stirling, made in the High Court of Justice on November 30, meetings of the holders of debentures issued by the above-named Company, and of the creditors of the said Company, as well as of the other creditors, were held at the Cannon-street Hotel on Monday last for the purpose of considering, and if thought fit approving, a proposed scheme of arrangement between such classes of creditors respectively and the said Company (a copy of which scheme accompanied the notice). And if such scheme were approved by the meetings, then for the purpose of electing Directors of the new Company to be formed as mentioned in such scheme.

Mr. D. DE CASTRO (the liquidator) occupied the chair.

The SOLICITOR to the Company (Mr. A. Trinder) having read the notice convening the meeting in the interests of the debenture-holders,

The CHAIRMAN said: Gentlemen, I really do not know that I have anything to say in addition to the information conveyed in the notice. The Company has been carried on by me as liquidator for the last six months, and as far as I can make out we have paid our way, and perhaps a little more than that, for we have paid off some of the debts of the old Company; but, of course, I cannot tell exactly what our position is until we have taken stock. But I have paid off arrears of rent, and also those creditors who could have taken precedence over others, and matters stand really where they were when I met the shareholders last July, I think it was. The scheme that has been laid before you speaks for itself. I presume you have read it through and considered it. If any debenture holder present has any question to ask about the scheme, I shall be very happy to answer it to the best of my ability. The great question will be, no doubt, what amount of support can we get from the debenture holders? I think there are debenture holders representing £8,000, and of this amount £5,000 was advanced by *bonâ fide* investors in debentures. The other £3,000 are debentures held by the Directors, who lent £3,000 to the Company for temporary purposes; so that you may treat the debentures as being of two classes—those that represent money invested as a permanent security, and those that represent money which was lent for temporary purposes. I think the holders of the debentures probably will find £4,000 towards the £20,000 required. I think that the creditors that I have spoken to will probably find another £4,000 or £5,000, and I am of opinion that there are some shareholders and absolute outsiders who will make up what I have had practically promised to me, if the scheme succeeds—namely, about £10,000. Then we would want another £10,000, which would have to be found somehow. That could be realised by an appeal to the public or to the shareholders unless the debenture holders of the £5,000 like to increase their stake. The Company is going on fairly well even in its present state of liquidation, and the prospects of the business, if it is carried on, are very good indeed. I can tell you that the orders that I have in hand at the present moment as liquidator amount to nearly £1,700, and that those which we feel pretty confident of being able to obtain—in fact, quite confident of being able to obtain if we go on—amount to nearer £8,000. The amount due from the customers has increased from £3,365, when I took matters in hand in July, to £3,667 at the present moment. There is, in fact, a variety of little details showing progress that I do not want to take up your time by going into at the present moment.

Mr. OGLE questioned whether the position of the Company had recently improved. The last time he attended a meeting was when they were taking power to issue debentures, and he remembered one of the Chairman's statements at that time was to the effect that the debentures were fully secured—that there were sufficient assets of the Company to pay the debentures, come what might. From the Chairman's statement now he calculated that the debentures would not be fully covered.

The CHAIRMAN said that, assuming the debentures to be good, they were very amply covered. But the question had been raised as to whether the debentures had been validly issued; but he did not think there was anything material in it. At any rate that question had been raised, and might have to be fought out. Assuming, however, the debentures to be good, the property was worth from £10,000 to £12,000 on a forced sale.

Mr. OGLE: What is the amount of the debentures?

The CHAIRMAN: £5,000 of the first issue and £3,000 of the second.

Mr. OGLE: What are the prior claims?

The CHAIRMAN: The prior claims I have paid off. There will be nothing now.

Mr. OGLE: The rent too?

The CHAIRMAN: I have paid off the rent. The only kind of creditor who had a sort of priority was one who gave us a machine payable by instalments, and that is reduced to about a couple of hundred pounds more.

Mr. OGLE: Then we may assume that the position is not worse than when you took power to issue the debentures? The material point then was that the debentures were fully secured, and that there would be something left to the creditors also on a sale.

The CHAIRMAN: I believe that to be the position now.

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The SOLICITOR said that the committee estimated that the lowest price that they would get for the Company's assets would be about £10,000.

Mr. OGLE presumed that they looked more to the shareholders and other people than to the creditors to reconstruct the Company by finding the necessary funds.

The CHAIRMAN explained that most of the debenture holders were also shareholders having a large interest in the concern. They were, in fact, the most powerful of the shareholders. They had always assisted the management up to this time, and he looked to them still for support. He looked to them for their own sakes to secure their debentures, and to obviate any possibility of litigation. It was a very tempting thing to solicitors, accountants, and all those who were interested in a good chancery suit to have a substantial basis to work upon, such as the Company's assets offered.

Mr. OGLE: "Wreckers."

The CHAIRMAN would not say "wreckers," but it was a good thing for such people to have a good company with £10,000 or £20,000 to work upon in a case of litigation, and he wanted as much as anyone to avoid the possibility of such litigation and the consequent waste of the Company's assets.

Mr. COTTON wished, in the interests of all concerned, to have a little more information from the Chairman in reference to the doubt that had been thrown upon the legality of the issue of the debentures. Did the objection come from one of the creditors, who, he supposed, would be the parties most interested in upsetting the debentures, and did it apply to all the debentures? He thought that they ought also to be informed of the nature of the doubt.

The CHAIRMAN explained that under the Articles of Association the Directors were not empowered to issue debentures beyond the amount of the uncalled capital for the time being. Thereupon the Directors called a meeting of the shareholders in the Company, and asked them to pass a special resolution to rescind the clause limiting their power, and authorising them to issue debentures for a limited amount, notwithstanding that the whole of the capital which had been issued was called up. The meeting to alter the articles was held on the 10th of the month of May, and the confirmatory meeting was held on the 24th, and the special resolution was registered as such, taking effect on that date. Now, the statute said that there should be 14 days' interval between the two meetings, and it appeared from a decision of Mr. Justice Chitty upon that clause of the Act that there must be an interval of 14 clear days between the two meetings, so that their confirmatory meeting ought to have been held on the 25th instead of on the 24th of the month. That was the exact nature of the objection which was taken up by one of the creditors. The serious question would arise whether it was a creditors' question at all—whether, in fact, it was not a matter between the shareholders and the Directors. In the latter case he submitted that the shareholders had confirmed, or waived, any irregularity by passing the accounts subsequently, and therefore it did not lie in their mouths to object to the validity of the debentures. As to the creditors, it would be submitted, if it were argued, that all that was required to be done to protect their interests was done. The debentures, purporting to be good, were registered; the creditors gave credit to the Company, knowing that that money was in existence, and the money obtained by the debentures was applied to the payment of those very creditors who were taking objection, and that would be part of the argument in defence. Another argument in defence was this—and it would raise a very serious question if it was fought out—that the Articles could not override the Memorandum, which gave the Directors absolute power to issue debentures without any limit at all. There was another kind of objection, but he supposed they all saw the nature of the dispute. It was a most trivial technicality and without a scrap of morality in it.

Mr. OGLE: Did the creditors take objection at the time that the debentures were issued?

The CHAIRMAN: Not at all, which is a material point.

The SOLICITOR said that it was in the interest of the debenture holders and everybody else that the scheme should be successfully carried out, so as to avoid all litigation.

The CHAIRMAN, in reply to a shareholder, said that what he had said had been based upon counsel's opinion, but the point raised admitted of argument in Court. A very material point was this. In his opening statement he mentioned that they were limited in their debenture issue to the amount paid up in the issue of capital. Now, as a matter of fact, they had a lot of unissued capital, which was an argument in their favour. While there was any capital unissued they need not have called the meeting. There were a great many arguments for the defence that the Court in such a case as this would duly weigh in their favour.

Mr. COTTON asked whether, if a debenture holder wished it, he could claim to be paid off?

The CHAIRMAN replied in the affirmative.

The SOLICITOR said the scheme was drawn up so that they might get by it enough cash to pay off the debenture holders. The latter would be asked to support the new scheme by taking shares in it; but if they did not wish to join it there would be no objection to their getting their money returned. Meantime, they were merely asked to sanction the scheme.

Mr. COTTON: What about the arrears of interest?

The CHAIRMAN replied that he had enough money to pay the amount, but he could not do so without the leave of the Court in the face of the legal objection referred to.

Mr. COTTON then formally moved, and Mr. FULSHAM seconded, a resolution authorising the scheme as printed and circulated among the shareholders to be carried out, which was agreed to.

The CHAIRMAN said that at an informal meeting of the creditors and debenture holders, a suggestion was made that the number of Directors should be increased to seven, and a discussion took place upon the question who should be the new Directors. It was decided that there should be two to represent the creditors, two to represent the debenture holders, and the same number to represent the shareholders, and that the six gentlemen selected at the three meetings to be held that day should themselves choose a Chairman, of some position and power, to keep the team in order. The names of Messrs. Henry Grewing and Thomas Lloyd were suggested as the two representatives of the debenture holders.

Mr. WALLACE then proposed that these two gentlemen be appointed Directors in the interests of the debenture holders.

Mr. KELLY seconded the motion, which was unanimously agreed to.

This concluded the business of the first meeting.

There was afterwards a meeting of the shareholders to ask their sanction to the proposed scheme.

The SOLICITOR, having read the notice convening the meeting, said there was one matter that he wished to explain, being solicitor to the liquidator. They all knew that previously a scheme on an entirely different footing had been submitted to the shareholders. After a great deal of trouble on the part of Mr. De Castro the £15,000 proposed to be raised to carry it out was got together; but unfortunately it had been too precipitately gone about, with the result that when the new Company came to consider the actual figures it was found, partly owing, perhaps, to the action of their friend, Mr. Mountain, in very energetically pushing forward the business, that some of the items under the head of cash assets had ceased to be cash assets, and were represented by stock. The effect of that was, that if the scheme had succeeded they would have had a larger amount of stock and a smaller amount of cash assets than appeared at first sight; and one of the Directors, who represented an entirely new element, raised a serious objection. That gentleman thought that the figures were not those that had been put before the shareholders, and that, in his view, the scheme ought not to be carried out. The effect of that decision was that the Directors of the new Company felt a great difficulty in executing the proposed agreement, and it was accordingly never executed. All the money subscribed to it had therefore been returned.

Mr. KELLY then proposed, and a SHAREHOLDER seconded, a resolution pledging the shareholders to agree to the proposed scheme.

Mr. A. J. KING wished before the motion was put to offer a few remarks. In a letter he had addressed to the Chairman he stated that he thought that the payment of 10 per cent. to the preference shareholders, coupled with the decision that anything earned beyond that amount should be shared by the "A" and "B" shareholders in proportion to their capital, was unjust, and hoped that that was not what was intended. It would be wiping out the "B" shareholders altogether. In that case he would be prepared to move an amendment to the resolution. Would the Chairman explain how the thing stood?

The CHAIRMAN said that he was sorry to say that he was not able to explain that the intention of the scheme was in accord with Mr. King's wishes. The idea was to give the preference shareholders—those who found the money to keep the Company on its legs—such an inducement as would cause them to find the money, and the least that could be given to them was 10 per cent. and the additional inducement of sharing with the ordinary shareholders in any surplus earned beyond that amount. The subject had been carefully thought out at great length, and they were afraid that they would not get the money from anybody except upon those terms. Of course, if the shareholders would come forward as a body to find the bulk of the capital, they could dictate their own terms, but unfortunately those who were dictating the terms at present were those who were to find the money. It was found by negotiating with the latter that they would not take anything less than those terms, and he was afraid that easier conditions could not be agreed upon.

Mr. OGLE said that he had found in the companies with which he had been connected that the usual custom was to issue 10 per cent. debentures. A 10 per cent. debenture was worth more than a 10 per cent. preference share. The only company he knew of that differed from that was the Russell Gold Mining Company, which proposed to pay 7 per cent. The only remedy of the "B" shareholders was to be "A" shareholders as well.

The CHAIRMAN: "Hear, hear."

Mr. OGLE was quite satisfied from his own experience that there was no chance whatever of obtaining money at 10 per cent. unless they undertook to give a division of the profits after that was earned.

The CHAIRMAN said he was very pleased that Mr. King had raised the question, because he was quite sure that that gentleman was the last man in the room not to acknowledge that he (the Chairman) had made the best terms he could for the ordinary shareholders.

Mr. KING asked what was the condition of the Company as regarded the past six months' working.

The CHAIRMAN said that they had done more than any other company in liquidation would have done. All through the summer they did quite as much as they did last year. They had not done quite so much in October and November as they did in the corresponding months of last year, but what had been done was done at very much less expense, and the prospects of work if this scheme were carried out were very good indeed, the Company having contracts for at least £8,000 in hand. He had no doubt it would surprise them to learn that they had tendered in the course of the year for *bonâ fide* work amounting to £300,000. He mentioned the fact merely for the purpose of showing the amount of work in the electrical world, a reasonable proportion of which they might expect to secure. He had blown the trumpet of the Gülcher Company so often that he was beginning to get afraid of saying too much about it, but the more he was associated with it the more convinced he was that it was a really sound concern.

The resolution was then put and carried.

On the motion of Mr. OGLE, seconded by Mr. FARMER, Mr. D. De Castro

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and Mr. W. Wallace were appointed Directors to represent the shareholders at the Board.

A meeting of the creditors was then held, and after the notice convening it had been read by the SOLICITOR,

Mr. JACKSON said that before the resolution asking them to approve of the scheme was put to the vote, he ventured to tell his brother creditors exactly the position in which they stood, because the somewhat voluminous documents which they had had submitted to them might not have been quite understood by all of them. As he had been in communication with Mr. De Castro, and ascertained all the facts of the case, he would endeavour to lay them before the meeting as briefly as he could, and then they could judge for themselves whether it was advisable to adopt the scheme or not. It would be useless to disguise from the meeting or the liquidator of the Company that there were serious questions depending upon it. The debenture holders held documents which, if sound, would entitle them to a claim over the other creditors; but if unsound it was perfectly clear that they were not likely to give up what they supposed to be their rights to anyone without a fight. On the other hand, if the creditors, as they were advised, were right in their contention that the bonds were informal, they were not likely either to hand over the proceeds of the sale of the Company without a fight. Now, a fight was no doubt a very pleasant thing to professional men, who had everything to gain and nothing to lose thereby; but he would be frank enough to say that for all parties concerned this ought to be the last thing they ought to resort to, because it would seriously damage the Company. If there was any *via media* by which they might adjust their respective claims it ought to be followed. Mr. De Castro proposed to start a company which, if he got all the money wanted, would pay all the creditors and debenture holders too. Therefore, *primâ facie*, he (the speaker) unhesitatingly believed that it would be to the interest of the creditors that they should support the proposal. They had been long-suffering creditors, he admitted; and there had been a long delay in getting matters brought to an issue, partly, of course, owing to the long vacation, and that delay was only now, apparently, coming to an end. He urged on Mr. De Castro, however, at an informal meeting, that that gentleman ought to tell the creditors of the Company how long he (Mr. De Castro) intended to prosecute the proposed scheme. If Mr. De Castro would undertake to say, after he had got everything into working trim, that he would be willing to limit himself to a moderate but definite time during which he would make his efforts to carry it out, no doubt the creditors would be better pleased than they would be if they were left in a state of suspense with regard to the matter. If they gave Mr. De Castro an absolutely free hand, they might be no better off six months hence than they were now. He thought that it ought to be the policy of the creditors to consent to the scheme on the understanding that Mr. De Castro gave some such assurance as he suggested, because he did not think that they should go on for an unlimited time.

The SOLICITOR said that if the scheme were approved that day, it had to be technically agreed to by the Court. Then the Directors of the new company would have to draw up their prospectus, and he did not see any reason why it should not be issued immediately after the decision of the Court was obtained, and then it would be for the Directors of the new company to say whether they could or could not, after a reasonable time, get the requisite £20,000. If the Directors came to the conclusion that they could not raise that amount, they would merely have to return such moneys as they received, and the assets of the Company would then have to be sold in the ordinary way. He did not think that there need be any understanding of the kind suggested. All they were asked to do was to approve of the scheme now before them.

The CHAIRMAN objected to having his hands tied in the matter, although he was in favour of doing something or other as quickly as possible, or of winding-up the whole concern. At the same time he believed it would be very unreasonable to go on beyond the end of February.

After a few remarks from Mr. BLYTH and Mr. HEADLAND,

The SOLICITOR pointed out that if the scheme could not be carried out within a reasonable time the parties concerned had the protection of the Court, not to mention the fact that if any individual creditor were aggrieved he had his remedy by taking legal proceedings to bring matters to a head.

The resolution approving of the scheme was then agreed to.

On the motion of Mr. LAMONT, seconded by Mr. BAILY, Messrs. Gustav Binswanger and Howard Lane were elected Directors to represent the creditors.

In deference to the wishes of Mr. Blyth and other creditors, a recommendation to the Directors to the effect that if the proposed scheme of reconstruction was not carried out by the 28th of February next the creditors should be again called together to consider the position or the scheme be dropped was agreed to, and the proceedings terminated.

CITY NOTES, &C.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 9th inst., amounted to £4,756, and for the week ended 16th inst. to £5,052.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY.—This company notify that the coupons due 2nd January next on their Five per Cent. Mortgage Debentures will be paid on and after that date at the banking house of Messrs. Barclay, Bevan, and Co., 54, Lombard-street, E.C. Coupons should be left three clear days for examination.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—This company notify the declaration of an interim dividend for the quarter ended 30th September last, of 2s. 6d. per share, free of income-tax, payable on the 14th January next.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—It is announced that the coupons due the 31st inst. on the debentures of the West Coast of America Telegraph Company will be paid by Messrs. Barclay, Bevan and Co. The coupons must be left three clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 16th inst. were £4,082, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half-month ended 15th December are £2,751, as compared with £2,222 in the corresponding period of 1886. The August receipts, estimated at £4,008, realised £4,107.

REMOVAL NOTICE.—The Pilsen-Joel and General Electric Light Company are removing their works and offices to their central lighting station at 4, Stanhope-street, Euston-road.

THE "SANITAS" COMPANY'S TRADE MARKS.—We are requested to give currency to the following:—Reports have been recently published of a case heard before Mr. Justice Kay, in which we (the "Sanitas" Company) applied to obtain the registration of our trade mark "Sanitas" in Class III. (being for "Chemical Substances prepared for use in Medicine and Pharmacy"), and as Mr Justice Kay, upon certain grounds, declined to accede to our application, many persons have concluded that the word "Sanitas" is no longer the recognised trade mark of this company. This is not a correct view of the case. Not only is the word "Sanitas" registered in Class II. ("Chemical Substances for Sanitary Purposes, such as Deodorants, Disinfectants, and Antiseptics") and in a great number of other classes, but further, we have two other trade marks which are registered in another variety of classes. It may further be stated that we retain to the full our common law right against imitations; indeed, so recently as October 27th last an injunction was granted, with costs, by the Chancery Division, High Court of Justice, restraining the defendant, &c., from infringing the company's registered trade mark "Sanitas" by any use of that term as applied to deodorant, disinfectant, or antiseptic preparations, soaps, and such like substances, and from advertising or selling, &c., any such preparations under the name of "Sanitas" or "Sanitant," or any compound or colourable imitation of the word "Sanitas."

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Dec. 21.		Business Done Week Ending Dec. 21. Highest.	Lowest.
Anglo-American	37,	38	37½	—
Do. Preferred	61,	62	62½	61½
Do. Deferred	13,	14	13⅞	13½
Brazilian Submarine	11⅞,	12⅛	12¼	12 1-16
Cuba	11¾,	12¼	12⅛	—
Do. Preference	18,	19	—	—
Direct Spanish	3½,	4	3⅞	—
Do. Preference	8,	9	—	—
Direct United States Cable	8⅝,	8⅞	8⅞	8⅝
Eastern Telegraph	11⅛,	11⅜	11⅜	11
Do. 6 per Cent. Preference	14¼,	14¾	14⅝	—
Do. 5 per Cent. Debentures, 1899	106,	109	108	—
Eastern Extension	12⅛,	12⅜	12⅜	12 1-16
German Union	9¼,	9¾	—	—
Globe Telegraph and Trust	5⅜,	5⅝	5½	5⅜
Do. Preference	13⅛,	13⅜	13⅜	13¼
Great Northern	13½,	14	13⅞	—
Indo-European	37,	39	—	—
London Platino Brazilian	4,	4½	4¼	—
Reuter's	8,	8½	—	—
Submarine	125,	135	130	123
West Coast of America	4¾	5¼	5⅛	4⅞
Do. Debentures	110	114	—	—
West India and Panama	¾,	1	1 3-16	11-16
Do. 1st Preference	9½,	10	10	9⅝
Western Brazilian	8¾,	9	8⅞	8 11-16
Western Union 7 per Cent. 1st Mortgage	120,	125	—	—
Do. 6 per Cent. Sterling Bonds	101,	104	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	9-16,	11 16	—	—
Oriental	¼,	⅜	—	—
United Telephone	11¾,	12¼	12⅛	11⅞
United River Plate Telephone	4¾,	5¼	—	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	2,	2½	2¼	—
Do. (fully paid)	2¾,	3¼	3	—
Swan	1¼,	1⅜	—	—
Maxim Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	38,	39	38¾	35¼
India Rubber, Gutta Percha and Telegraph Works	20½,	21½	21⅝	21

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 502.—Vol. XX. FRIDAY, DECEMBER 30, 1887. Price 4d.

NOTES.

It is just a year ago (on Tuesday last) that the great snow-storm fell which wrought such memorable destruction amongst the overhead wires. The condition of the streets of London on Monday, December 27th, 1886 (and, indeed, for many a long day after), was a sight to be remembered for a lifetime. However, the damage has all been repaired by this time, the losses have been pocketed, and the country has been pacified by the assurance that according to the recognised laws of nature (founded on observations extending over at least twenty years) there will not be another such storm for nine years to come. It should, however, be borne in mind that even if another severe storm should return before the period assigned, the wires are in most cases decidedly better prepared to meet the strain than they ever were before—we are speaking mainly of overhead wires in towns. Much was done to improve the condition of the lines after last year's storm; spans were shortened, stouter poles were erected, and stays and struts were increased in number.

There can, however, be no doubt that still more—much more—might be done to increase the security of our overhead wires if the United Telephone Company were granted some such Parliamentary powers in the matter of way-leaves as they are now once more seeking to obtain. It is without doubt desirable to move cautiously in matters of this kind, where the individual rights of property are to some extent involved; but we are of opinion that the United Telephone Company will be able to make out a very good case. It is, for instance, simply intolerable that the owner of a building in one of the busiest parts of the City, by refusing to permit wires to pass *over* his roof, should have the power to cause a very large number of wires to be carried twice diagonally across a wide street. In a case of this nature it is evident that the unsightliness, inconvenience, and increase of risk to the community far outweigh in importance the merely sentimental objections of the individual against wires stretching over, but not supported by, his roof. We are therefore of opinion that, subject to proper supervision, and the right of protest and compensation for actual injury, such concessions as the company seeks may be safely granted.

While writing of overhead wires we may allude again to the remarkable fact mentioned last week in our account of the Brighton Central Lighting Station, that during five years not a single span of wire has ever given way. Some of the credit of this record is possibly due to the excellence of the engineering, but probably still more is due to the difference between the conditions of the telephone and the electric light service. It is well known that the gathering of snow or ice upon the wires is the most frequent and serious cause of their coming to grief. This is, however, impossible in a No. 8 wire conveying a current of 10·5 amperes, the temperature being thereby maintained several degrees above that of the air. Then again, in the electric light service, the number of wires on a single route is very limited and there can be no fear of pulling down the supports.

The price of copper continues to rise, and the speculation which is running it up has now assumed a rather alarming character. A Berlin financial organ roundly asserts that an alliance has been formed between the members of the Société des Metaux on the one side, and the London house of Rothschild —although this is denied—on the other, to buy up every ton of copper that comes into the market before the 1st November, 1888, on the understanding that in the interval none is to be sold below £70. The facts have now to be seriously faced by the electric lighting industry, as it is scarcely possible to hope that prices will return to anything like their former level for a long period to come. This would not be so much a matter for regret if the movement were closely accompanied by a general advance in prosperity all round; but, as things are, the improvement in trade has not yet had time to affect electric lighting very closely. The electric light already labours under sufficiently heavy burdens in this country without being called upon to suffer further for the benefit of a few unscrupulous speculators.

We learn with satisfaction that Mr. Willard E. Case is continuing his researches upon the reversible batteries of the type which (in the autumn of last year) he was the first to make known. A full account of Mr. Case's original heat-cell may be found in *The Electrician* of Aug. 6th, 1886. In this cell the elements consisted of carbon and tin, and chromous chloride was employed as the electrolyte. At a temperature of 60deg. F. the cell has no measurable E.M.F., but at 140deg. F. it attains an E.M.F. of a little over 0·2 volt. When exhausted it, has only to be allowed to cool down in order to regain its original chemical constitution. No hydrogen is evolved during either charge or discharge, and therefore it is

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ideally possible that a cell of this type should last for ever without renewal of material or any other attention besides the supply of energy in the form of heat. In the form originally described by the inventor it was evident that for certain reasons, of which the smallness of the E.M.F. obtained is the most prominent, the results could not be expected to be of a highly economical, nor even, perhaps, of an entirely practicable character. But attention having once been awakened to the possibility of effecting a conversion of energy of this type there could be little doubt that substantial improvements would be effected. It is only the more satisfactory that the improvements should be effected by the original discoverer of the method.

THE discovery of the chemical reaction upon which Mr. Case's earlier cell is based was made, however, by M. Henri Loewel, and is described in the *Chemist*, Vol. VIII., page 476. A solution of chromous chloride added to stannous chloride precipitates tin, but when the solution is heated to about 140deg. F., the metal is re-dissolved, and the original salts are formed. Chromous chloride is, however, a difficult re-agent to employ, as it readily absorbs oxygen from the air, forming the oxychloride, which is insoluble.

AT present, we have only somewhat meagre details of Mr. Case's new cell, but we understand that chromous chloride has been replaced by chromic chloride (probably for the above-named reason), and that the tin is employed in the form of a liquid amalgam. The precipitated tin formerly rested at the bottom of the cell upon a horizontal plate of carbon. The addition of mercury is therefore probably chiefly with the view of making better contact.

THE low E.M.F. must, however, still be an insurmountable obstacle to the practical success of the cell on any extensive scale, and it is evident that if the direct conversion of heat can be profitably effected in this manner it must be by some different combination of elements. What is wanted, therefore, is a suitable chemical reaction reversible with change of temperature (such change not exceeding the limits of, say, 20deg. C. to 100deg. C.), and capable of yielding, with carbon as a negative electrode, an E.M.F. of respectable proportions. Such cells would form an ideal battery for household use, and would clear primary batteries altogether out of the field, or rather, the house.

IT appears from some statistics recently published that of the 886 miles of tramway lines now worked in the United Kingdom 232 belong to local authorities. The fact is worth noting in view of the early introduction of electrical power in our provincial towns, and its probable adoption by the municipal bodies. The possibilities of utilising the current for electrical locomotion, as well as the electric light, should be a great inducement to assume the powers which some of the towns already possess, and which all may acquire, under the Electric Lighting Act. By generating power in the daytime, the running of the tram lines and the lighting of the streets would mutually assist in cheapening both systems. Every town installation should take account of this contingency.

THE *Daily News* quotes a statement to the effect that during the last twenty years "more than one hundred English and French patents for perpetual motion have been obtained." That is to say, the Governments of these countries have enriched themselves to this extent out of the pockets of so many fools and dupes. What a satire on the Patent Laws!

THE report of the tests carried out at Cincinnati on the cost of lighting the railway station by gas and by electricity (a copy of which will be found elsewhere) is a curious document, though perhaps a trifle too vague and obscure to repay any very serious criticism. The fact that some of the Edison meters were found to register backwards is, however, a matter of some importance, especially to the shareholders of the companies employing that system. The reporter was, moreover, informed that the phenomenon "is not unfrequent," which, as he justly observed, "seems strange." But the company is not to be baffled by a discrepancy such as this, and it appears that the inspectors are instructed to note the difference between the weights of the two plates without troubling themselves as to the (purely theoretical) distinction between cathodes and anodes.

IN the third edition of Sir David Salomons' work on the "Management of Accumulators," the author (on p. 105) gives the following definition of Edison's meter—"A thing of the past, depending upon the deposit of some metal." We are, unfortunately, a little doubtful as to the immediate accuracy of the first part of this description, inasmuch as we are under the impression that this apparatus is still extensively employed by the Edison Company of the United States; but in the light of the statements alluded to above there can be little doubt that Sir David's description will sooner or later be perfectly accurate.

AS to the "deposit of some metal," which appears at present somewhat erratic, we suppose the balance is made up on the settlement of the account. But if these complaints have any foundation, it is perfectly clear that the error is entirely against the company. As we recently had occasion to remark in our articles on the Brighton installation, the Edison plan, by which a fraction only of the current supplied is measured, can be accepted as little better than a makeshift at the best.

WHILE writing of coulomb-meters we may note that our contemporary, the *Electrical World* of New York, describes an addition to the Forbes meter, which has been introduced by Mr. R. M. Hunter as an "improvement." Mr. Hunter has observed that in the original apparatus no arrangement exists for giving warning in case the rotation of the vanes should cease while the current was on. By an ingenious device, involving the addition of a second set of vanes, it is arranged that in the event of the first set coming to rest the motion of the second set closes a relay contact, which immediately cuts

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the installation out of circuit. We fear, however, that Mr. Hunter's suggestion is not of a very practicable character. It would be rather hard on the consumer to cut him off because his meter went wrong by accident, and on the other hand if the first set of vanes were tampered with it would be equally easy to stop the action of the second.

For electric lighting installations, a current indicator or volt indicator is generally quite as useful in regular work as an ammeter or voltmeter. It is scarcely necessary to explain that by the term indicator is meant an apparatus which will show whether the volts or amperes are or are not at the normal value, and, if not, in which direction they are at fault. Such an instrument has only to be calibrated for one particular value, and ought, for that reason alone, to be much cheaper than a meter. Moreover, as they are only intended to be used at one particular current strength—whether indicating volts or amperes—there is no objection to the employment of soft iron. We recently described one simple form of current indicator, which is in use at Brighton, and this week we describe an instrument of the same type which has for some time been employed by the Anglo-American Brush Company.

Probably some use might be found for an alternating-current volt indicator. The principle of induction current deflections, which has recently been investigated by Dr. Fleming in this country and by Prof. Elihu Thomson in America, would obviously lend itself to this end. (On the last-named subject see *Electrician*, May 6th, May 20th, and June 10th, 1887.)

Some exception has been taken to the explanation given by the Secretary of the Society of Telegraph-Engineers and Electricians in respect to the Cloak Room arrangements on the occasion of the President's *conversazione*. If it were a mere question of fact, we might of our own observation admit the inadequacy of that explanation; and we should certainly contradict the "chief porter," if he were speaking as a servant of the Institute of Painters in Oil Colours. But on this occasion he was not acting in that capacity; and we invite our friends to remember that whatever inconvenience fell to the guests of Sir Charles and Lady Bright, the annoyance caused to themselves as our entertainers must have been still harder to bear.

Our New York letter had not come to hand this week up to the time of going to press.

Cable Repairs.—The cable between Trinidad and Demerara has been successfully repaired.

Theatre Lighting at Edinburgh.—The Lyceum Theatre at Edinburgh was lit by electricity for the first time on Monday evening.

Colliery Lighting.—The Ffrwd Colliery, near Wrexham, has been lighted throughout by electric light. The installation has been carried out by Mr. Charles Lever.

Dynamo Award at the Adelaide Exhibition.—Messrs. Crompton and Co. have received an award of the first order of merit for their dynamo machines exhibited at the Jubilee Exhibition at Adelaide.

Mill Lighting.—The Hope Paper-mill, Cefn-y-Bedd, North Wales, has been lighted throughout by electricity. The dynamo has a capacity of 5,000 watts, and is driven by water-power. The installation has been carried out by Mr. Charles Lever.

American Telegraphs.—A petition has been filed at Washington for the incorporation of the Postal Automatic Telegraph Company, which intends to establish a line across the Continent from New York to San Francisco. The capital is £600,000, with power to increase it to £4,000,000.

China.—The *Etoile Belge* states that the Van Rysselberghe system of simultaneous telephone and telegraph working is to be carried out upon the line between Shanghai and Tien-Tsen. The Chinese officials were much astonished and delighted with the experiments shown them by M. le Baron Satorine.

Berlin.—The General Company of Electricity of Berlin, with a fully paid-up capital of £250,000, has issued £350,000 of additional shares at a rate of 122 for 100. Forty thousand pounds' worth were taken beforehand by MM. Siemens and Halske, and the rest is subscribed for several times over, all fully paid.

Bradford.—The Electric Lighting Scheme.—The sub-committee of the Gas Supply Committee, who are charged with the duty of carrying out the electric lighting scheme, have passed a resolution in favour of calling in "as a consulting adviser in connection with the scheme the most eminent authority on the subject whose services can be obtained."

Waterford.—It may be remembered that when the Waterford Corporation entered into a contract with Messrs. Laing, Wharton and Down for the supply of a Thomson-Houston plant for street lighting an oil lamp was adopted for the more unimportant streets and thoroughfares. We are now informed that "these oil lamps have been found so unsuitable that the whole lot are now discarded."

Lighting Buoys by Electricity.—An attempt is to be made to light some of the buoys in New York Harbour by incandescent lamps supplied with current from the shore. We shall be pleased to hear of the success of this scheme, but fear that it will encounter difficulties of the character to which we referred last week in connection with the attempts to establish telephonic communication with buoys.

The Dublin Scheme.—In a paragraph from a Dublin journal quoted in our last issue the scheme which has received the approval of the Town Council was spoken of as having been drawn up by the City Engineer. As a matter of fact, and, as our readers have already been informed, the plans and estimates were drawn up by Mr. E. Manville of the United Electrical Engineering Company, Albert Embankment, S.E.

Government Legislation and the Telephone in Italy.—The Roman journal *Bollettino delle Finanze, Ferrovie e Industrie* of December 25th, states that the Minister of Public Works has formulated a project of law for regulating the construction and working of the telephone lines. The bill is reported to be framed upon the report of the committee appointed by the late Minister of Public Works to consider the subject.

Paris.—Some French engineers and electricians are indulging in pleasing visions as to the possibility of obtaining motive

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power in Paris for 350,000 eight candle-power lamps, or 8,000 arcs of 2,000 candle-power (besides obtaining a splendid water supply) by means of a high-level canal from the lake of Neuchâtel, in Switzerland. The project is at present quite in the nebulous stage, but we shall hope to hear more of it some day.—M. Santon has given notice that when the Budget for the ensuing year comes before the Municipal Council he will move that a sum of 1,000,000f. be set apart for the introduction of electric light by the Municipality.

Telegraph Classes at Birmingham.—The annual distribution of prizes and certificates in connection with the Birmingham Postal Telegraph Science Classes took place on the 21st inst. in the school attached to Carr's-lane Chapel. Councillor M. Pollack (mayor) presided, and there was a good attendance. The annual report stated that 54 students joined the science classes at the commencement of the session, and were distributed in classes as follows:—Technical telegraphy, 29; magnetism and electricity (advanced), 13; elementary, 20. Five sat for examination in technical telegraphy and two passed, one in the honours stage and one in the ordinary stage. Several also passed in magnetism and electricity.

Electrical Engineering in the United States.—At the meeting of the Mason College Engineering Society, Birmingham, held on Wednesday, the 7th inst., Mr. Edward L. Joseph read a paper on the interesting subject named above. The author dealt with the various branches of the science as applied in the American industries, and gave a good idea of the various electrical companies and the business they are doing. He congratulated English electricians on the fact that nearly all the instruments of precision and other delicate work used in the States are of English make. The interest of the paper was enhanced by the fact that Mr. E. L. Joseph has spent considerable time in the States, and was able to speak with practical knowledge of the subject.

A Long Wire Span.—*Indian Engineering* says:—"A remarkable engineering feat has just been carried out in China in the face of unusual physical obstacles. This was the stretching of a steel cable of seven strands across the Luan river by Mr. A. de Linde, a Danish Civil Engineer, aided only by unskilled Chinese labour. The cable is strung from two points 4,648ft. apart. The height of one support is 447ft. above the present level of the river and the second support 737ft. above it. The vertex over the water is 78ft. The Chinese cable is the longest but one in the world. The telegraph air cable across the Kistna has a span of 5,070ft.; two similar cables cross the Ganges, one 2,900 and the other 2,830ft. A third line of 1,135ft. crosses the Hooghly, and in the United States there is one over the Missouri of 2,000ft."

Electrical Heating.—Increased attention is being paid to the employment of electricity for the distribution of heat. Dr. W. Leigh Burton (of Richmond, U.S.) has recently introduced an electrical heater, which we understand the Edison Company of the United States are not unlikely to adopt. This heater consists of a fine platinum or German silver wire, bent into a loop, and covered with fireclay. An electric stove of a different type was recently described and illustrated by our contemporary, the *Electrical World* of New York. This apparatus is modelled on the lines of an ordinary gas stove. It consists of a row of incandescent lamps placed in front of a burnished reflector in such a way that the lamps themselves are invisible, while the heat may either be thrown forward into the room or may be concentrated in an upward direction when it is wished to use the stove for culinary purposes

Progress in Austria.—A correspondent of *Industries* states that, though the central station in Salzburg has only been started a few weeks, the demand for light is rapidly increasing, and the supply of current is already five times as large as it was at starting.—Neuhaus, a town in Bohemia, has also received an installation of arc lamps, overhead conductors being employed.—Next year there will be a Trades Exhibition in the Rotunda, and as it is intended to keep the exhibition open in the evening, a liberal use of electric lighting will be made. The interior of the buildings will be lit by various local firms, whilst the grounds and approaches from the Prater will be lit by the Berlin Allgemeine Electricitäts Gesellschaft. The Vienna firms have approached the Minister of Commerce with a request to take over the installation which they are going to put up, as a permanent feature of the building. This proposal he has promised to consider, provided the cost of the installations be moderate.

The Phœnix Fire Office Rules.—The eleventh edition of these rules has now been issued. The principal alteration since the last edition is the addition of the following important clause in Rule 19 dealing with transformer installations:—"It is preferable that a transformer be so constructed that a leak between primary and secondary coils is rendered impossible. When, however, this is not the case, then the secondary work might be protected by an approved automatic apparatus (or arrangement) at or near the transformer, so that in the event of the difference of potential between the secondary conductors and the earth rising at any time to 400 volts, then the apparatus will instantly act and cut off the current. These recommendations are not obligatory at present, except in those particular instances that may be deemed necessary by the Inspector from the Fire Office." A clause almost identical with the above has appeared already in an earlier edition, but it was afterwards decided to withdraw it for a time until further experience had been gained. It will be seen that the clause has not yet been made obligatory.

The Telephone in Canada.—The following are the latest available statistics of the telephone in Canada:—

Cities.	Pop.	No. of subs.	Rates.
Baltimore	333,000	1,965	$80
Boston	594,000	2,450	120
Cincinnati	285,000	2,714	100
Cleveland	161,000	1,886	72
New Orleans	216,000	1,481	96
Pittsburgh	249,379	1,727	190
Detroit	116,000	2,363	72
Paris	2,236,000	4,500	120
Montreal	200,000	2,000	50
Toronto	100,000	1,900	50
Hamilton	43,000	760	37

From the above it will be seen that Montreal, with a population of 200,000—or less than one-tenth the population of Paris—has almost half as many telephones, with the prospect, as soon as the new company gets into operation, of a largely-increased number. In Montreal there is one telephone to every 200 inhabitants, in Toronto one to every fifty-three, in Hamilton one to every fifty-seven, and in Paris one to every 4,946.

German Dynamo Patents.—Messrs. Siemens and Halske, of Berlin, recently applied to the German Patent Office for the protection of a type of dynamo with internal poles. The application was opposed by Messrs. C. and E. Fein and also by the Helios Company, of Cologne, on the ground of prior use. The Berlin correspondent of *Industries* mentions that this protest has been supported by the Patent Office on the following grounds: "There have been prior publications, notably Patent No.

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13802, covering the principle of internal magnets placed radially, and the manner of supporting the external armature laterally has also been anticipated in Patent No. 13158. Although these designs have previously been chiefly used for alternate-current machines, it cannot be contended, with the present general knowledge of dynamo electricity, that the application of the design to continuous-current machines is a patentable novelty. Moreover, such application has already been forestalled in Patent No. 19265." This decision will show how very strict the Patentamt is in dealing with inventions for which patents would be granted in England as a matter of course.

The Oerlikon Plating Dynamo.—The following figures relate to one of five 50-unit machines recently built at the Oerlikon Works to the order of the Società Elettrometallurgica of Turin. The original order was for one machine only, with the specification that it should be capable of running continuously, with a stop of only five minutes in each 24 hours. The machine not only met this requisition, but it was found that after 14 hours' continuous running on full load and long after stationary conditions of temperature had been reached, the following conditions were observed :—

Temperature of armature	140° F.
„ „ field-magnets	85° F.

The following are the details of these machines :—

Tension at terminals	115 volts.
Current	440 amperes.
Output	5,600 watts.
Electrical efficiency	95 per cent.
Total weight	14,700lb.
Field Coils.	
Length of wire	15,500ft.
Diameter of wire 3 millimeters, or	0·118in.
Sectional area of wire, 7·069 sq. mm., or	0·109in.
Resistance	11·10 ohms.
Current	10·36 amperes.
Turns	3,370.
Ampere turns	34,913.
Watts lost	1191·4.
Ampere per 1 sq. mm. of section	1·46 ampere.
Armature.	
Axial length	21·6in.
Diameter	23·6in.
Total length of wire	476ft.
Total weight of wire	223lbs.
Sectional area 78·54 sq. mm., or	0·122 sq. in.
Resistance	0·0075 ohm.
Amperes per 1 sq. mm. section	2·8 amperes.
Watts lost	1,525.

The Cost of Central Station Lighting.—A correspondent of *Industries*, signing himself "Contractor," writes the following letter in criticism of the recent article in that journal on the cost of central station lighting, an abstract of which appeared in our issue of the 9th inst. :—"Your article will be read with great interest by many electrical engineers and others interested in electrical subjects. On reading it over I, however, notice that you have, as is usual in such calculations, entirely omitted to consider the question of how your income is to be obtained. In your third column you state most definitely that you provide energy for 60,000 60 watt lamp-hours daily throughout the year. If we suppose that you sell your electricity at 8d., which price has been settled as the lowest that is likely to yield a return in London, you will find that the above supply will yield a gross income of £43,750 per annum. After that, you state that the supply will be taken through 150 transformers of various sizes, from which we must understand that each consumer will have his own transformer, and that the average annual payments that will be obtained from each consumer for electricity supplied will be £290. Now, it is needless to point out that this can never be the case over any extended area of supply ; that, in fact, it is probable that the average maximum sum that you can expect the public to pay for lighting an ordinary London dwelling house or shop will be from £20 to £30 ; and if we take £25 as a mean, it follows that to produce the above income 1,750 houses must be connected to the system, with a corresponding number of transformers, and length of house frontage and of distributing mains. I should have little difficulty in proving to you that under such conditions the present temporary expedients of overhead wiring and house connections, which appear so favourable to the cost of the alternating transformer system, are as inadmissible for this as for the battery transformer system. The increased number of transformers, house connections, and cost of underground distributing mains would then so greatly alter the comparative table of cost which you furnish, that instead of the cost for lights used simultaneously being about £6 and £3 respectively, it will be about £5 for both systems, and that this sum would cover five lights fixed, so that each light fixed would cost about £1."

Telephony in Austria.—A correspondent writes us from Vienna as follows :—"Because in Austria there are about 3,000 subscribers only to telephone exchanges it is constantly said that Austria is behind other States in this respect. Of the 3,000 about 1,000 are in Vienna. It is a question if there could not be more there, but as business is very bad in Austria, especially in Vienna, it certainly does not seem likely. Why are there not more in Austria? is the question, and the answer is simply because there are so very few towns of any size, and still fewer commercial or manufacturing towns; and where there are no towns telephone exchanges are not wanted. Austria is an agricultural country, and cannot be called a manufacturing or trading country. On the other hand, those towns which are commercial have already telephone exchanges, and in them the number of subscribers will compare very favourably with those of any other towns of similar size in Europe; and the charges still more so, whilst the service is known to be excellent. The following table will prove that most of the towns outside Vienna are well supplied with telephones, especially in proportion to the number of inhabitants :—

Prag	200,000	inhabitants,	516	subscribers
Trieste	120,000	„	427	„
Lemberg	100,000	„	226	„
Graz	98,000	„	222	„
Czernowitz	45,000	„	101	„
Pilsen	38,000	„	111	„
Reichenberg	28,000	„	232	„
Bielitz	13,000	„	137	„
Linz	41,000	„	130	„
Brünn	83,000	„	250	„

The first eight of these are worked by the Telephone Company of Austria. The charges vary, according to the size of the town, from £5 to £7—a very low charge. Out of these on'y Prag, Trieste, Reichenberg and Bielitz can be called commercial or manufacturing towns, to which Brünn must also be added. No doubt there is further room for increase, and the Austrian Government have wisely decided to open exchanges in the remaining towns, and it is understood that at the beginning of next year exchanges are to be started in Krakan, Salzburg, Innsbruck, Marburg, Moran, Wiener Neüstadt, Baden, Gablenz, Karlsbad, Teplitz, Troppan, Laibach, Görz, and others."

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SOME ENGLISH CENTRAL LIGHTING STATIONS.

I.—BRIGHTON.

(Concluded from page 153.)

(Concluded from page 153.)

Method of Testing Incandescent Lamps.

A very simple method of testing incandescent lamps is in use at Brighton. It consists in comparing the *colour* of the hot filament with that of an albo-carbon gas flame. This is done, not by a direct comparison of the lights, but by comparing their individual shadow-tints. The test may be thought a somewhat rough and ready one, but a careful series of experiments carried out by Mr. Wright some two years ago led him to believe that, so long as the operator has a good eye for the detection of minute variation of tint, the test is really capable of very great accuracy. These experiments were conducted with lamps supplied by four different makers, namely, Edison-Swan, Lane-Fox, Woodhouse and Rawson, and Swinburne, and the conclusion was arrived at that when burning at the same colour (that is to say, at the same temperature) the consumption of energy is at the rate of 3·6 watts per candle for each lamp. The total candle power is therefore obtained by dividing the watts by 3·6, and under the conditions of the test it is known that the lamps are burning at the same number of watts per candle power.

The Method of Working.

The following is the daily routine of the station:—During the hours of daylight the small Hornsby engine and the 16-light dynamo are sufficient to supply the requirements of the town, and the whole of the circuits are during this period connected together in series. Towards evening steam has been got up, and one of the large Fowler engines is ready for work. It is now necessary to divide the circuit into two parts, and to place the heavier portion on one of the larger dynamos, leaving the small machine to work the lightest circuit. We will explain presently how this is done. As more lamps are switched on, the E.M.F. at the terminals of the second machine gradually rises, until the shunt regulator reaches its limiting position; at this point a bell rings as a signal for increased E.M.F., as already explained in describing the method of regulation. This increase might, of course, be obtained by increasing the speed of the engine, which is supposed to be running at half speed at present. But there are still four machines standing idle, and the speed of the engine will not be increased until each of those machines has been brought into service. The previous operations are therefore repeated, a third machine is started, the circuit is again divided, and the E.M.F. at the terminals of each machine remains for the time being within the limit attainable at the particular rate of driving. This series of operations is repeated until all five machines are at work, each on its own circuit; after this condition has been reached the next signal for increased E.M.F. is responded to by increasing the speed of the engine. The engine is made to govern at the altered speed by altering the tension of the governor spring. The engine is usually started at forty revolutions, and the speed is increased about one revolution at a time, until the maximum of eighty-five revolutions has been attained. Later on in the evening the lamps begin to diminish in number, and the operations just described are successively reversed, until the circuits are again all in series and the Hornsby engine again takes charge of the all-night work.

Switching Over.

The whole of the operations above described are carried out not only without interruption to any of the circuits, but also without producing the slightest perceptible variation or flicker in any of the lamps. The procedure is as follows:—

The machine to be introduced is first started at the proper speed, with a variable liquid resistance shunt on the armature, and with the field shunt regulator at its lowest position—that is, with a shunt of small resistance. The machine being in this condition it is then brought into the circuit of the dynamo which is already at work. This is done in the usual way, by first connecting the machine with two terminals on the switchboard, through which the current is passing, and then withdrawing a plug between them. The current is now passing to the line through the armature and shunt of the second machine; but the latter is generating very little E.M.F., because its field is fully shunted. The next proceeding is to gradually withdraw the shunt from the armature until the full current is passing through it. The shunt upon the field can now be allowed to rise, and the automatic regulator coming into play the potential is adjusted and maintained at the proper point.

The two machines are now working together in series upon the looped circuits. The separation of the lines into two distinct circuits is effected by so adjusting the automatic regulators that the E.M.F. produced by each machine is sufficient to drive the current through the circuits each is going to supply. When this is done the circuits are separated by simply turning an ordinary cut-out switch.

When shutting down for the night, the same series of operations can be performed in reverse order; but this is not usually done, as the necessity of avoiding any interruption to the light is absent at 1:30 a.m. Although somewhat complicated to describe, it will easily be seen that the system adopted is really very simple and straightforward, and provided no blunder is made by the manipulator, the operation can be performed with ease and certainty.

Cost of Production.

We have already mentioned that the consumers are charged at Brighton at the rate of 1s. per unit, or kilo-watt-hour. This is of course a very good price, and is, in fact, one of the highest on record, but Brighton is a wealthy place and can afford to pay for a luxury. The cost of production does not, however, leave a very large margin of profit on the capital outlay. The actual figures have been very carefully worked out, the observations extending over a long period, and the exact cost is now known to a fraction. It amounts to 9·313d. per unit. This result may, perhaps, appear a little uncomfortable in the light of the fact that there are schemes already in progress elsewhere in which it is proposed to supply electricity at rates not much exceeding half what it costs at Brighton. The consideration that will probably first recur to the reader is that the dynamos at Brighton are of old and somewhat inefficient type; and, next, it will be remembered that the whole installation consists at present of only some 1,500 lamps. The following detailed analysis of the expenditure enables us, however, to obtain a clearer view of the relative importance of these and other considerations:—

	d.	Per centage.
Wages	2·580	27·7
Coal	2·180	23·41
Water	·192	2·06
Oil and Waste	·290	3·12
Carbons	·338	3·63
Office Expenses	·581	6·23
Salaries	1·260	13·53
Rent and Taxes	·725	7·78
Repairs	·287	3·08
Petty Disbursements	·030	0·86
Depreciation	·800	8·60
	9·313d.	100·00

It is not our intention to enter upon a full discussion of this table, but there are one or two points which may be dwelt on briefly. It will be noted that depreciation is entered in the second column as 8·6 per cent., but it will be seen that this is not the average rate per cent. which is charged upon the capital account, but only the relative value of this item in the actual cost of production. Next it will be seen that the consumption of coal and water, which are the only items varying directly with the total output, amounts to no more than 25 per cent. of the total. This is a point of considerable importance. It shows, for one thing, how easy it is to over-rate the advantage of high commercial efficiency in dynamos for central station work. An increase of 10 per cent. in the efficiency of

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the machines would in this case affect the total cost of production by only $2\frac{1}{2}$ per cent., or, in other words, it would reduce the cost of one unit from 9·313d. to 9·08d. Mr. Wright holds the opinion very strongly that mechanical strength and solidity of construction, together with facility for effecting repairs, is to be preferred in a dynamo machine before high efficiency of conversion. It is for these reasons that he has been content to run the station with the old Brush machines, though, as we have already hinted, preparations are in progress for replacing them wholly or in part by modern alternate current dynamos.

With this chapter we close our account of the Brighton Central Lighting Station for the present, but we shall return to the same place in a few weeks' time in order to describe the alternating current distribution which Mr. Wright is now introducing.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY A. E. KENNELLY.

CHAPTER V.—*Current (continued).*

(Continued from page 155.)

46. With submarine and subterranean conductors, however, the conditions are such, for reasons we need not at present enter upon, that the variable period is generally very much greater than that for overhead wires of the same length. The Thomson recorder shows this very clearly, for supposing that the current received on a long cable arrived immediately at its full strength, and that the coil and siphon responded immediately—that is to say, had no retarding friction or inertia—then the received signals would always be as shown in Fig. 16, and the application of a permanent current would produce a right-angled out-

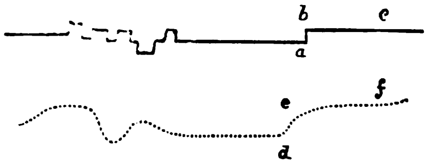

FIG. 16 AND 16A.*

line like *a b c*; but owing to the gradual rise and fall of the current during the variable periods preceding and succeeding an application of the battery to the sending end, the slurred signals and curved line, *d e f* (Fig. 16A), are actually received. On a long submarine cable the current which passes from the cable to earth one second after the application of the battery to the distant end may be perhaps only 40 per cent. of the full ultimate current. After three seconds the current will probably be very nearly at its full strength, but many seconds must elapse before the maximum can be said to have been reached.

47. It is clear, therefore, that it is incorrect to speak of the velocity of electricity. If, for instance, an indicating instrument be set at the receiving end of a line, and the time which elapses between the application of a battery at the sending end and the indication of this instrument be measured, we can say that this signal required that particular interval of time to be produced over that distance of line under those circumstances; but by altering the sensitiveness of the instrument and the form, dimensions, and position of the line we can make the time required to transmit that signal as great or as small as we please; and, so far as is known, there is no time of transmission over any given distance so short that by still further altering the conditions it might not be made yet shorter, so that under these circumstances it is impossible to assign any velocity as inherent to electricity, like that which we attribute, for example, to light in its passage through space.

* The curve *d e f* is accurately given on a larger scale at p. 329, Jenkin's "Electricity and Magnetism," 2nd Edition.

48. After the variable period has passed, however, the current in a circuit will continue to flow, under the control of much more simple laws, at a constant rate, so long as the conditions of that circuit remain constant. The strength of current is proportional to the conductivity of the circuit when the E.M.F. in that circuit is constant. This almost follows from our conception of the term conductivity, for if a certain circuit offers a given degree of facility to the passage of a current supplied by a constant E.M.F., then it follows that by doubling that degree of facility we double the current flow, and if we make the conductivity 0·2, 0·9, 15, or 1,000 times what it was at first, we shall with the same E.M.F. obtain 0·2, 0·9, 15, or 1,000 times our first current.

49. When the conductivity of a circuit is constant, then the strength of the current which flows through it is proportional to the E.M.F., just as the flow of water through a pipe is proportional to the difference of level or "head," which drives it. So that by doubling the E.M.F. in a circuit of constant conductivity we double the amount of current flowing through the circuit, and if we make the E.M.F. 0·005, 0·7, 16, or 1,000 times what it was at first with the same conductivity, we shall get 0·005, 0·7, 16, or 1,000 times the original strength of current.

50. The unit strength of current is called the *ampere*, after the French physicist of that name. It is the current which flows in the circuit of unit conductivity containing the unit E.M.F. That is to say, one volt in a circuit of one mho generates a current of one ampere. It follows, therefore, from what we have seen in paragraph 48, that the current in a circuit of one volt and two mhos would be two amperes, with one volt and 50 mhos, 50 amperes; also by what follows in paragraph 49 that with two volts and 50 mhos, it would be 100 amperes, with 50 volts and 50 mhos 2,500 amperes, and in the same way with $\frac{1}{2}$ a volt and $\frac{1}{4}$ of a mho $\frac{1}{8}$th of an ampere; so that in all cases the current in a circuit is found in amperes by multiplying the E.M.F. in volts by the conductivity in mhos. This simple and vitally important statement of facts is named after its discoverer, Ohm's law. Since, however, we have seen in paragraph 30 that the conductivity of a circuit is the same in mhos as unity, divided by the number of ohms in that circuit, we may to find the current multiply the E.M.F., not by the number of mhos, but by their equivalent unity divided by the ohms in the circuit's resistance; in other words, divide the E.M.F. by the resistance. Thus we have seen that a circuit containing five volts and of 0·025 mho conductivity, would sustain a current of $5 \times 0{\cdot}025$, or 0·125 amperes. But the resistance of the circuit would be $\frac{1}{0{\cdot}025}$, that is, 40 ohms, so that we arrive at the same result if instead of multiplying 5 by the conductivity 0·025, we divide it by the resistance 40, that is $\frac{5}{40}$ or $\frac{1}{8}$, or 0·125. So that as it is much more usual to speak about a circuit's resistance in ohms than its conductivity in mhos, the common expression of Ohm's law is that the current in a circuit is obtained in amperes by dividing the E.M.F. by the resistance. Thus, in a circuit of 100 volts and 1,000 ohms, the current would be $\frac{100}{1000}$, or 0·1 ampere, and by our previous rule the conductivity being $\frac{1}{1000}$, that is, 0·001 mho, the current would be $100 \times 0{\cdot}001$, or 0·1; of course, precisely the same result.

51. This unit current or ampere is that which transmits the unit quantity of electricity in one second. The unit of electric quantity is called the coulomb, and just as the unit flow of water through a pipe might be taken as that which allowed one gallon of water to pass any point in the pipe during one second of time, so the ampere is the strength of current, the rapidity of flow, which allows one coulomb to pass any point in the circuit during one second. So that if a constant current of one ampere has been flowing for 100 seconds in a circuit, then we know that 100 coulombs of electricity have passed any point in the circuit during that time. In the same way a steady current of five amperes flowing for one minute causes

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a total transmission of 5 × 60, or 300 coulombs, and generally the quantity of electricity in coulombs transmitted by a constant current is the product of that current and the number of seconds it has been in flow.

52. For convenience in telegraphy a submultiple of the unit, the milliampere, is in very common use; it is the thousandth part of an ampere. To give an idea of what a milliampere practically is in telegraphy, it may be mentioned that on Morse land line circuits receiving becomes difficult to adjust and sustain when the received working current falls below one milliampere, which may be regarded as a minimum working current, while 5 milliamperes—that is, 0·005 amperes—is a good average working current. The current which enters the line at the sending end may be greater, and in the case of a long line in wet weather perhaps much greater than this; but the difference escapes by leakage at the insulators along the line, just as a quantity of water forced into a long pipe containing many small leaks would be much reduced in amount before its issue at the distant end.

53. The working current in a telegraph circuit whose insulation is good—so that the current escaping by leakage need not be considered—is easily found by Ohm's law. Suppose, for example, that we have an overhead land line 50 miles long, of 13ω resistances per mile, worked in the manner represented at Fig. 17—that is, on the open circuit principle, where no current passes through the line, except in actual signalling. The stations A and B are each provided with a Morse key, K, for sending the currents, a galvanoscope, G, of 30ω resistance, for observing that those currents duly pass, a Morse inkwriter or sounder, M, of 200ω resistance, and a battery, E, of 11 volts and 200ω total internal resistance. The levers of the keys are normally kept back by the spring *p* on the receiving contacts *r*. Under these

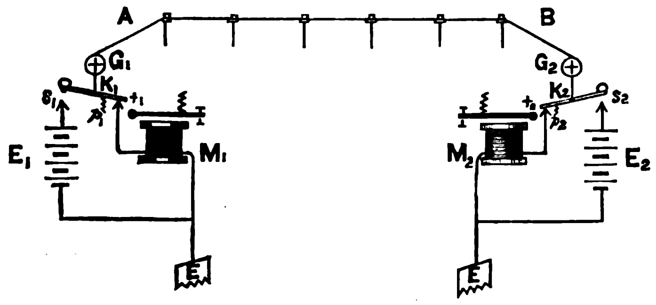

FIG. 17.

circumstances there is a complete circuit from A over the line returning by the earth and both receiving instruments, but in this circuit there is no battery. When A depresses his key, however, the circuit is completed no longer through the back stop and receiving instrument but through the front stop *s* and battery E, and a current from the latter therefore flows to line and actuates the galvanoscopes and instrument S. While A's key remains depressed we know from Ohm's law that the strength of current at any point in the circuit—there being assumed no leakage—will be the total E.M.F., namely 11, divided by the total resistance, which we can sum thus—

A's battery B	200ω
A's galvanoscope G........................	30ω
The line A B—	
Fifty miles at 13ω per mile	650ω
B's galvanoscope G........................	30ω
B's instrument M	200ω
The earth connections and the earth perhaps	1ω
Total	1,111ω

The current flowing will therefore be

$$\frac{11}{1111},$$

or $\frac{1}{101}$th part of one ampere—that is, 0·0091 ampere or 9·1 milliamperes.

(To be continued.)

A CURRENT INDICATOR FOR ARC-LIGHT CIRCUITS

We illustrate herewith a simple form of current indicator which is employed by the Anglo-American Brush Company. Fig. 1 shows the instrument set up, and Fig. 2 shows the various parts. From the latter figure it will be seen that the apparatus consists of a flat, square-shaped iron core, or armature, which is balanced on knife edges, projecting from the sides near the lower edge. It has therefore a tendency to fall on either side of the vertical. A long index needle is fixed at the top. This arrangement is placed within a solenoid

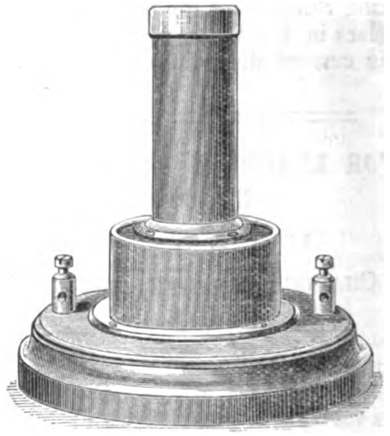

FIG. 1.

connected with the main circuit. On the passage of the current the armature tends to assume the vertical position, and this is opposed by the action of gravity. The index needle does not lie quite in the same plane as the prolongation of the core, hence it reaches the 10-ampere mark at the middle of the scale before the core itself attains a vertical position. By

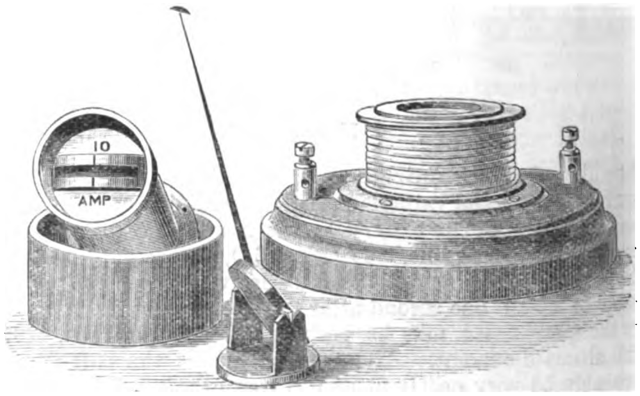

FIG. 2.

this arrangement the indicator is able to show an excess as well as a deficit from the normal current for which it is set.

THE MANUFACTURE OF INCANDESCENT LAMPS—AMYLOID CARBONS.

BY NELSON K. CHERRILL.

What was said last week tended to show that variation in the converting effect of the acid on the cotton thread would be found a fertile source of variation in the carbon produced; but I think we may go further than this, and may state almost with certainty that the process as carried out commercially contains in its very essence the germs of failure. If the action of the acid is cut short of complete conversion, the cotton may have still more of the characteristics of the fully converted article. It will still have the appearance of catgut,

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and will cut easily in the dies used to reduce its diameter; but on examination under the microscope, or a strong lens, it will be seen still to retain evident traces of fibrous form; the original twist of the cotton will be often seen indicated by lines in the substance of the thread. If now such a sample of cotton be more fully converted, it will most likely be found to be quite cleared from the traces of fibrous form; but at the same time there are ten chances to one the cotton will be made too weak to draw through the dies, and it will consequently be condemned as rotten. In fact, to put the matter in a nutshell, if the acid treatment is prolonged to that point at which absolutely no fibrous traces remain, the cotton is generally too weak to draw well. The tendency of manufacture is therefore decidedly to use cotton too little rather than too much prepared. Now suppose that we carbonise a piece of quite unprepared cotton thread and examine the result in the microscope, we shall find a loose aggregation of carbon fibres having no cohesion one with another. If a piece of such a carbon filament be placed in a compressor (such as a tin box or lever compressorium) under the microscope, the various carbon fibres will be seen to move about amongst each other when the pressure of the covering glass is varied. When by the action of the acid the cotton fibres are, as it were, glued together, the resulting carbon presents under microscopic examination a like homogeneity of substance; but it is easy to see that if the action of the acid has been at all cut short of the most complete conversion there must always be a tendency for the inner fibres to be left loose in the burning, and hence I take it that in any thread which shows any sign of structure there is a serious liability for the lines which indicate structure to develop under firing into lines of imperfect homogeneity. It is impossible to judge of this point in the microscope, but the behaviour of the carbons when a current is passed through them may often be taken as an indication of their structural condition.

I shall have something to say on this point next week.

ELEMENTARY NOTE ON THE CALIBRATION OF GALVANOMETERS.

Galvanometers, or current-meters for large or small currents, which are not constructed on the tangent principle require to have their scales graduated in divisions proportional to the currents passed through them; or, if their scales are marked out in degrees of arc, a number of readings must be taken with currents of known ratios, whose values, together with the corresponding deflections of the galvanometer, are plotted on a curve for reference when currents are measured on the instrument.

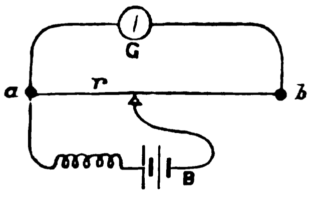

Fig. 1.

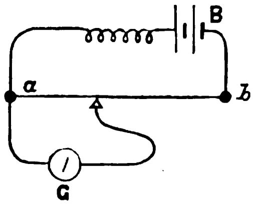

Fig. 2.

If a galvanometer (such as a tangent) or ammeter, whose proportionality to the current is known, is available, it may be connected in series with the ammeters to be tested, and *any* currents passed through for comparison.

Prof. Grassi, in a paper read before the Naples Academy in June last, proposes some modifications of Nacarri's method for the graduation of a galvanometer in divisions proportional to the current by the simple movement of a sliding contact on a stretched wire, the distances moved over being proportional to the currents through the instrument.

The arrangement in Fig. 1 would be used for a low-resistance galvanometer.

The current through the galvanometer with the pointer or sliding contact D in any position on the wire A B will be

$$\frac{E r}{r_1 (R+G)+r(R+G-r)} \quad . \quad . \quad . \quad . \quad (1)$$

where

r_1 = resistance of battery and any resistance in battery circuit.
E = battery E.M.F.
R = resistance of wire A B.
G = resistance of galvanometer.
r = resistance of portion of wire between A and sliding contact D.

The denominator comprises two terms, the first of which is constant and the second variable.

If, now, the resistance r_1 is made very large in comparison to G and R, the variation in the value of the denominator —while D moves the whole length of A B—is very small compared to the actual value of the denominator. We may therefore take the latter as constant, and if the E.M.F. is constant, the currents through G vary as the distances of the sliding contact from A.

It is evident that the greatest variation in the denominator when G = R is R^2, and when G has any other value the maximum variation is $\frac{(R+G)^2}{4}$. This being made very small compared to r_1 (R + G) by a resistance inserted in the battery circuit, the arrangement is suitable for the graduation of low-resistance galvanometers.

Reversing the positions of battery and galvanometer as in Fig. 2, we have an arrangement for graduating high-resistance galvanometers.

The current through G will be

$$\frac{E r}{G(R+r_1)+r(R+r_1-r)} \quad . \quad . \quad . \quad . \quad (2)$$

Comparing this with (1) we see that G and r_1 have changed places, and therefore when $r_1 = R$ the maximum variation of denominator is R^2 and when r_1 is any other value the variation is $\frac{(R+r_1)^2}{4}$ This must be small compared to $G(R+r_1)$ which is effected by employing the method with a high-resistance galvanometer, and low-resistance battery.

Prof. Grassi improves the accuracy of the method for cases where the resistances of the galvanometer and battery more nearly approach each other by employing two slide wires, A B, of resistance R, and M N of resistance n R (Fig. 3), these two being connected together through a travelling contact, D. The current through galvanometer for any position of contact D is

$$\frac{E r}{(R+G)(r_1+nR) + (R+G)(1-n)r-r^2} \quad . \quad (3)$$

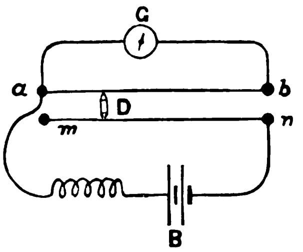

Fig 3.

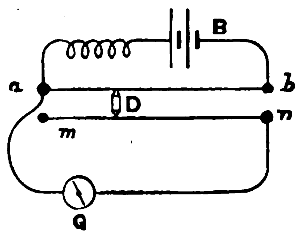

Fig. 4.

Calling this denominator V, we have its value changed to V_1 when the pointer is at the end B

when $$V_1 = (R+G)r_1 + RG \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and to V_0 when the pointer is at A

when $$V_0 = (R+G)\ (r_1+nR)$$

and the greatest possible value of the denoninator would be

$$V_2 = (R+G)(r_1+nR) + \frac{(R+G)^2}{4}(1-n)^2.$$

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It is found that the minimum variation is attained when $V_0 = V_1$, and therefore $n = \frac{G}{R+G}$, with which values the variation is reduced to $\frac{R^2}{4}$, and this is quite independent of the resistances of the galvanometer and battery. If a low resistance galvanometer is used n becomes very small and nR negligible, and we revert to the single wire as in Fig 1.

Similarly if the battery and galvanometer are reversed (Fig. 4) the current through G is

$$\frac{E\,r}{(R+r_1)\,(G+n\,R)+(R+r_1)\,(1-n)\,r-r^2} \quad . \quad (5)$$

and the maximum variation in the denominator becomes $\frac{R^2}{4}$ by making $n = \frac{r_1}{R+r_1}$.

We see also that by employing a low-resistance battery nR becomes negligible, and we revert to the single wire, as in Fig. 2.

Under the above conditions the currents passing through the galvanometer to be graduated, or whose scale divisions require to be checked, are proportional to r, viz., to the distance of the sliding contact from the point A, and this it is seen can be done without knowing accurately any of the resistances in the circuit.

ELECTRIC OSMOSE AND ELECTRO-CAPILLARY ACTION.*

Assuming with Clausius that in a case of electrolysis taking place in a liquid between, say, platinum electrodes, a polaric *bias* is put upon the otherwise chaotic evolutions of the molecules of the electrolyte by the E.M.F. of the current, it seems not unlikely that if the + and − ions be of unequal mass and the forces urging them in contrary directions be equal, *more work will be done upon the lighter radicles* than upon the heavier ones at each semi-revolution of the molecules of the Grotthus chains (after each liberation of ions at the electrode surfaces), owing to the difference of inertia; and that the liquid will in consequence be urged towards that electrode towards which the lighter radicle is moving; also, that if a friction be introduced by placing a porous diaphragm or a series of porous diaphragms across the liquid, the back flow of the liquid *within the pores will* be retarded, and a difference of level on the two sides of each septum limited only by the strength of the current and the efficiency and thickness of the septum will be produced.

I have been led to think that this action may account for the phénomena of electric osmose and allied effects by the following considerations:—

(1) Electric osmose is most marked in electrolytes whose molecules are of great relative unwieldiness and disparity of weight between their + and − components, as in the case of organic compounds.

(2) The ion moving towards the cathode (H in the majority of cases) is generally the lighter of the two ions, which accords with the rise of liquid around the cathode in general. In cases which would seem to contradict this hypothesis it may be that the elements *visibly* liberated at the anode are not the only ones which accompany the − ions on their journey and add to their inertia.

(3) That by reason of more work being done on the + ions than on the others the cathode is more strongly bombarded than is the anode by the elements liberated against it, so that if either electrode be varnished on one face and floated, or made with vanes like Crookes's radiometer, or hung in the liquid, pendulum fashion, it will move to or fro with different force to the other in like circumstances, as in the capillary electrometer of Dewar.

(4) That the facts are not less consistent with the rather-more-difficult-to-grasp view that the active molecules of the Grotthus chains, in performing their semi-revolutions from the positions in which they are formed at every change of partners, following the liberation of each pair of complemental ions at the ends of the chains, swing round their centres of mass; and even if their centres of bulk be coincident with their centres of mass it may be that the friction they exert against contiguous molecules in turning "right about face" is greater or less for one direction of reversal than for the other, owing to the different nature of the two halves of each molecule. Wherefore the whole of the active molecules are impelled one way, and all the inactive molecules the other, with equal momentum but not necessarily equal volumes.

(5) That if the centres of bulk of the active molecules be displaced, their friction against neighbouring molecules will, by their being disseminated in infinite number throughout the liquid, urge it as a whole in one direction just as a net of fine mesh would do.

(6) The apparent disagreement between this hypothesis and the fact that—at least, when the electrodes are fixed—the + and − ions each undergo equal displacement in opposite directions, as evidenced by their being given off in equivalent quantities at the electrodes, will be seen to be *only apparent* when it is remembered that every time a + and − element is liberated at the ends of the Grotthus chains, those chains are left one molecule too short, and that there is an abundance of molecules ready to fall into file all along the line, so that more will therefore fall in at that end from which the active molecules tend to be displaced. R. SNOWDON.

Staveley Ironworks, Chesterfield.

* A communication to the Electrolysis Committee of the British Association, Manchester, 1887.

OBSERVATIONS ON ATMOSPHERIC ELECTRICITY.*

BY PROF. L. WEBER.

I will try to give a short report of some experiments I have made during the last year in regard to atmospheric electricity. It was formerly uncertain whether the electrostatic potential would increase by rising from the surface of the earth to more elevated regions of the atmosphere or not, and also whether the potential in a normal—that is, cloudless—state of the atmosphere was always positive or sometimes negative. Sir Wm. Thomson found by exact methods of measuring that the increase of the potential with elevation is very important, and values about 100 volts per metre. That fact is proved by many other observers, especially lately by Mr. F. Exner at Vienna, who found an increase of 60 to 600 volts per metre. These observations were made by means of an electrometer. In respect of many inconveniences which are connected with the use of an electrometer, I have tried the measurements with a very sensitive galvanometer. In this case it is necessary to apply a separating air-exhaust apparatus, for example, flame, or a system of points at the upper end of the conductor, which is elevated in the atmosphere. In order to get a constant apparatus I have used 400 of the finest needles inserted in a metallic ribbon. This system I have raised in the air by means of a captive balloon, or by a kite, which was attached to a conductor of twine or to a twisted line of the finest steel wire. In this way I have attained a height of 100 to 300 metres. When the lower end of the kite line was communicating with the galvanometer whose other terminal was in contact with the earth, a current passed through the galvanometer. For determining the strength of this current I proposed to call a micro-ampere the 10^{-9} part of an ampere. At the height of about 100 metres in the average the current begins to be regular, and increases at the height of 300 metres to 4,000 or 5,000 of these units. The increase is very regular, and seems to be a linear function of the height. I have, nevertheless, found the smallest quantities of dust contained in the atmosphere or the lightest veil of cirrus disturbed the measurement very materially, and generally made the potential lower. In negative experiments of this nature I have made at Breslau, at the Sohneekoppe, and at the "Reisengebirge," especially at the last station, an

* Abstract of a paper read before the British Association Meeting at Manchester, Sept., 1887.

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increase of potential was observed, not only by reason of the perpendicular height, but also by reaching such regions of the atmosphere as were situated horizontally to about 200 metres from the utmost steep of the same mountain, Sohneekoppe. Therefore it must, according to Mr. Exner, be assumed that the surface of the air presents a surface of equal potential, and that the falling surfaces of high potential were stretched parallel over the plane contours of the air, and more thinly or narrow lying over all the elevated points, as for example, mountains, church towers, &c. On the basis of these facts I think it easy to explain the electricity of thunderstorm clouds; in fact every cloud, or every part of a cloud, may be considered as a leading conductor, such clouds as have for the most part perpendicular height. After being induced the change results by supposing the conduction of electricity either from the upper or from the lower side, according to greater or smaller speed of the air in the height. In the first case the clouds will be charged positive, in the other negative. I am inclined, therefore, to state that the electricity of thunderstorm clouds must be considered as a special but disturbed case of the normal electric state of the atmosphere, and that all attempts to explain thunderstorm electricity must be based on the study of the normal electric state of the atmosphere.

A THOMSON BRIDGE FOR THE MEASUREMENT OF SMALL RESISTANCES.*

Messrs. Siemens and Halske have in process of manufacture a bridge of the pattern devised by Sir William Thomson, and

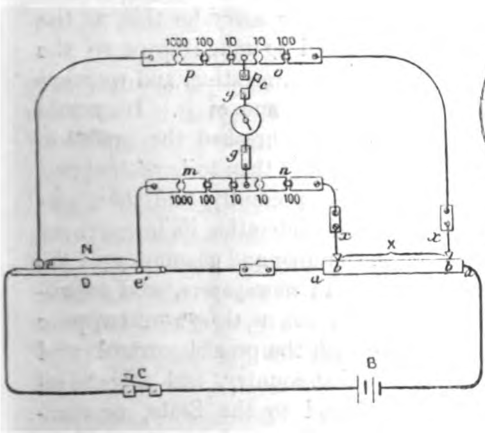

Fig. 1.

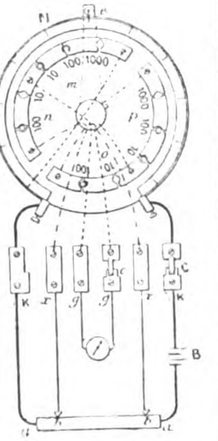

Fig. 3.

especially designed for the rapid and accurate measurement of small resistances. It will be remembered that the chief value of this arrangement lies in the fact that the influence of the spurious resistances due to the contacts with conductor of low resistance is entirely eliminated. The conductor whose resistance is to be measured is balanced against an arm of the bridge whose resistance is of the same order; but the resistance of the remaining branches of the circuit (which are in series with one or other of the four *contacts* of the low resistance conductors) are of a higher order, and hence these contact resistances are negligible. The bridge in question is adapted to the measurement of resistances varying from 0·1 ohm to 0·000,001 ohm.

Fig. 1 shows the diagram of the connections. The principal circuit is made up of the battery B, the key C, a conductor, D, and the resistance X, whose value is to be determined. Two points, *e e′*, in the conductor D, and two points, *b b*, at or near the extremities of the conductor X, are respectively connected with a pair of resistance boxes, as shown. The galvanometer bridges the circuit between the two arms of the resistance boxes.

If the total resistance in the branch m = that of branch n, and likewise $o = p$, there will be no current in the galvanometer, and then $X = N$,

* From the *Elektrotechnische Zeitschrift.*

where N equals the resistance of conductor D between the points $e\ e^1$.

This resistance N can be varied within limits by sliding one of the contact pieces e. In this way resistances can be measured whose value is at the maximum not greater than that of N. If the resistances of N and X are very different, the resistances m, n, o, p are adjusted so that

$$\frac{n}{m} = \frac{o}{p}.$$

We have then $X = N\,\frac{o}{p}$, and the value of X as read by the slider has simply to be multiplied by a decimal constant.

In the instrument of MM. Siemens and Halske, which is shown in Fig. 2, the conductor D consists of a circle of palladium, which is fixed upon a wooden block. The circle is finely divided at the margin. The sliding contact e is made by a movable arm pivoted at the centre of this circle, and provided with a vernier for accurate reading. The contact e' is fixed.

The plug contacts of the resistances m, n, o, p are arranged around the same circle. The terminals for the remaining connections are placed upon the front of the base board, and the manner of joining up will easily be seen on comparing Fig. 3 with Fig. 1, in which the same lettering is employed. Flexible wires are connected to the points $x\ x$ for joining up the resistance to be measured.

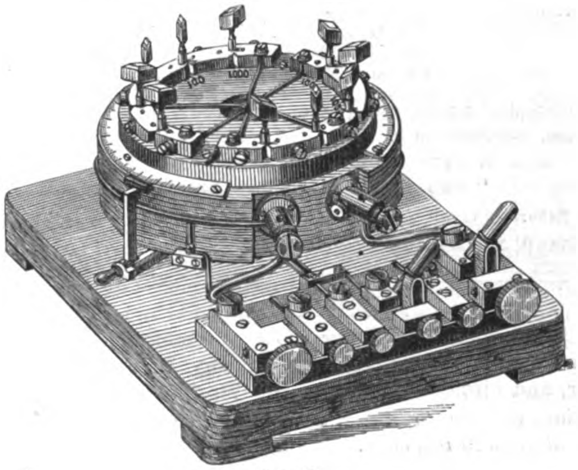

Fig. 2.

As an example of the employment of the apparatus, suppose that $n = 10$, $m = 1{,}000$, and $N = 0{\cdot}0051$, we should then have

$$X = 0{\cdot}0051 \times \frac{1}{1000} = 0{\cdot}000051 \text{ ohm.}$$

This new model of the Thomson bridge is a very practical piece of apparatus, and will unquestionably be extremely useful in facilitating the measurements of minute resistances.

MEETINGS OF SCIENTIFIC SOCIETIES.

(Week ending Thursday, 5th January.)

SATURDAY, December 31st.

Royal Institution.

3 p.m. The Third of a Series of Six Lectures (adapted to a Juvenile Auditory) on Astronomy. By Sir Robert Stawell Ball, LL D., F.R S.

MONDAY, January 2nd.

Society of Engineers.

Meeting.

WEDNESDAY, January 4th.

Society of Arts.

Juvenile Lecture I. "The Application of Electricity to Lighting and Working." By Mr. W. H. Preece, F.R.S.

*** Particulars of meetings to be held or papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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The Electrician.

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THE TELEGRAPH IN AMERICA.

Our latest intelligence from the United States seems to point to the abandonment, for the present at all events, of the movement for establishing a telegraph system under the control of the Government. We are rather sorry for this, as the discussion which has recently occupied so much space in the American papers was beginning to be interesting, and we were growing curious to see what would come of it. It would have been more satisfactory to have thrashed the question out thoroughly while they were about it than to have dropped it suddenly, only to take it up again presently, and then perhaps settle it off-hand without the consideration its importance demands. If we may judge by the number and unanimity of the opinions extracted from the American newspapers, and reproduced in the technical journals which reach us, there would appear to be widespread dissatisfaction with the present control and management of the telegraphs in that country, and a general desire to have them either transferred to the State, or compelled to give a better service by its active competition. "Never," writes one of these authorities, "were the people more in favour of a Governmental control of the telegraph;" and most of the papers at the commencement of the month spoke in the same strain. Subsequently, however, there came the President's message, proposing the reduction of import duties; and in the excitement caused by this announcement the other question has been temporarily set aside.

If we are to take this as the inauguration of a settled change of policy, the surplus revenue going to reduce import duties more and more every year, then probably the question of buying or creating a Government telegraph system will be postponed indefinitely. But the principles of Free Trade have not made such headway in the States as to warrant this conclusion; and it seems to us more than probable that in the present condition of political parties the advantages of possessing a national telegraph system will outweigh those of enjoying the unrestricted importation of foreign commodities. America is unique in having a surplus revenue which she does not exactly know what to do with; and unless she is now about to make a departure in her fiscal system differing altogether from her established traditions, that surplus will again very soon be available for reforming the telegraph service of the country, and will, we imagine, be devoted to that purpose. Perhaps

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the delay may be of some advantage, for although Bills appear to have been prepared for the forthcoming Congress, the country is not yet entirely agreed as to the form which the measure should take—whether for the buying up of the existing telegraphs, or the institution of an independent system under the control of the Government. Until this preliminary point is settled, obviously no progress can be made in the Legislature; and it is a point of such immense importance that no time can be considered wasted which is devoted to discussing it thoroughly.

The question which our friends in America will have to determine before they spend a single cent on this undertaking is, whether they are going to enter on the business of telegraphy as monopolists or as competitors? If the former, the operation will be a gigantic one; but it is one that money will pay for, and is by no means beyond the resources of a country that collects more taxes than it can honestly spend. If the latter, then the question arises, or would very soon arise when the competition began, is the country so rich as to afford to squander money year after year on a war of rates with its private competitors, increasing the telegraphic facilities beyond all reasonable requirements, and removing further and further away the possibilities of absorbing at a reasonable figure the whole system into Government hands? That the existing companies could be brought to their knees by a simple threat of Government opposition is incredible; and to confront the companies on even terms the Government must establish a system equal in magnitude to theirs, when one or the other would be superfluous. A purchase under such conditions would be inevitable, but would be waste of money at the best. We say inevitable, because it would be the policy of the private companies to hold on and fight the battle until the State became sick of taxing the public all round in order to carry on a ruinous business merely for the benefit of the senders of telegrams. Private property is more secure in the United States even than with us, its sanctity being formally recognised in the Constitution. Confiscation, or compulsory purchase at marine-store-dealers' valuation—which is sometimes talked about in this country—is therefore out of the question; and it follows that by postponing the day of purchase the price at which it can be effected will be proportionately enhanced.

Notwithstanding these self-evident considerations, an influential body of public opinion in the States is at present favourable to competition rather than purchase. The reason is not far to seek. So obnoxious has the monopoly of the principal telegraph company become, that to crush it by competition is regarded as an act of justice, while to buy it up seems like a piece of extravagant magnanimity. And this feeling is intensified by the personality of the one man who largely owns and wholly controls the existing monopoly. One of the chief demerits of personal government, whether in politics or trade, is that it is provocative of envy, hatred and all uncharitableness. Porbably neither Mr. JAY GOULD nor the Western Union Telegraph is guilty of a tithe of the enormities laid to their charge; but even were it otherwise, the fault would rest very largely with the Government which has permitted the amalgamation of the c ompanies, the creation of a vast monopoly, and the domination of the great capitalist whom the American press anathematises as "that man." Speaking impartially on this point, we venture to observe that the Americans ought to be thankful that these evils can at any time be easily set right; and that the inferiority of the Government in those qualities of boldness, enterprise, and foresight which the private companies have displayed may be condoned by prompt decision and cash down. We ourselves were behind the rest of Europe in placing the telegraphs under Government control; but when we did so we paid for our backwardness. And this, we suspect, is what the United States Government would have to do in like circumstances.

On the question whether or not the United States should follow the example of Europe in assuming the control of the national telegraphs we offer no decisive opinion. All that we confidently assert is that to be effectual the control must be complete. The Government must have a monopoly, for the working of which it will be responsible to the country. It will never do to permit two or more identical systems for the public service with public control over only one of them. Our own experience in relation to the telephone ought to be a warning to America. Notwithstanding the Government monopoly a vast telephone system has been allowed to grow up outside of it, and, except for the payment of a small royalty, independent of it. The telephone is rapidly developing a business which threatens to seriously invade, if it does not exactly rival, that of the Postal Telegraphs. This is serious enough in its financial aspect; but in the interest of the public it is even still more serious. Already there is much dissatisfaction because the telephone service is not what it ought to be. Being in private hands it is worked exclusively for profit; and the Government is blamed, first for taking the royalty, next for not creating a more perfect system of its own. The fact is, the Government cannot afford either to dispense with the one or to competitively run the other. Meanwhile the companies do what seemeth to them best, and the country complains that this important branch of telegraphy is not covered by the thirteen millions sterling which was paid for establishing the Government telegraphs eighteen years ago. How this difficulty will be got over it is hard to say, but certainly not by the competition of the Government; far more probably by its acquisition of the rights of the existing telephone companies.

ELECTROLYSIS OF IRON SALTS.

BY ALEXANDER WATT.

(Continued from page 157.)

Chlorides of Iron and Magnesium.—To prepare this bath a solution of acid protochloride of iron was first neutralised with carbonate of magnesia and then filtered. The clear liquor was then electrolysed with the current from three small Daniell cells, in series, when a dark bluish-grey film was immediately obtained upon a brass cathode. Two cells were next tried, when, as before, the deposit took place instantaneously; the solution was now diluted and a fresh plate immersed. The deposition being still too quick, however, more water was added to the bath, when the character of the deposit improved. The current from a single cell was next tried, with still further advantage, since the film now became whiter and more bright. With the single cell there was but little evolution of gas, but in a short time the liquid became murky. A moderate addition of a solution of chloride of magnesium was now made, and the solution well stirred, when it at once became light and clear. A freshly-prepared brass plate was then immersed, which soon became coated with a film of iron of a good white colour and very adherent. The deposition being still rather more speedy than was desirable for a good reguline and tenacious deposit, the anode surface was reduced to about equal that of the negative electrode, when the deposit took place more gradually, and the character of the film greatly improved. There was, however, considerably more gas eliminated after the addition of the magnesium salt, and the hydrogen bubbles had a tendency to rest upon the plate.

Chlorides of Iron and Sodium.—A moderately strong solution of the protochloride of iron was first made, and to this was gradually added a strong solution of carbonate of soda, until the liquid was neutral to litmus paper. With the current from three Daniells, and large anode surface, a partial film of iron slowly formed on the brass cathode, and at the same time a white gelatinous deposit appeared on the plate, which was ejected from the surface by the hydrogen (which was very copious), and finally deposited at the bottom of the vessel. A few drops of hydrochloric acid were now added to the liquid, when the solution became clear; the anode surface was also increased, when a bright film of iron slowly formed upon the plate. The solution was next diluted with about double its volume of water, and a small quantity of common salt added and dissolved in the liquid, when the deposition immediately improved in every way, being not only more rapid, but the film became perfectly bright, and of a brilliantly white colour. It was found necessary now, however, to reduce the anode surface considerably, little more than half that of the cathode being sufficient. It was next determined to reduce the number of cells, 1 and 2 cells respectively being tried, but the most suitable current was obtained from the latter number of cells in series, and equal electrode surface, with which a fine white and remarkably bright and adherent film was obtained at a fair rate of deposit. Although this solution of the mixed salts is capable of yielding very favourable results, it is scarcely one that could be recommended for practical working, inasmuch as it might be somewhat uncertain in its performance as an electrolyte, unless the current and anode surface were regulated, as we have seen, to a degree of nicety that is scarcely so necessary with some of the solutions described in the former papers of this series.

Nitrates of Iron and Potassa.—This bath was prepared by adding to a solution of protonitrate of iron one of nitrate of potassa, the compound solution being of moderate strength. The current from a single Daniell cell was first tried, when a dull, opaque film of a non-metallic character—probably a subsalt of iron—was obtained upon the cathode. Two cells were next tried, with similar results. A third cell was then connected in series, when, after a short immersion of a brass cathode, a dark green salt formed upon its surface, and in about two minutes after accumulated on the plate as a green spongy mass, finally falling off the surface and depositing at the bottom of the vessel. This green salt, when exposed to the air, oxidised with great rapidity, forming a rusty compound of somewhat brighter colour than ordinary rust of iron. No metallic deposit of iron could be obtained from this bath with any modification that suggested itself, either in strength of current or density of the liquid, so the experiment was abandoned. It should be mentioned, however, that the dark green salt referred to sometimes formed an adherent film—apparently transparent—which could only be detached from the plate by force, while the remainder of the same material, which formed the upper layer of the deposit, came away from the plate spontaneously, or was easily removed by wiping it off with the finger. I may mention the fact that I have frequently met with the same dark green, semi-adherent substance when electrolysing some of the persalts of iron.

Iodide of Iron.—This salt was first prepared by digesting fine iron wire in warm water, to which was added a quantity of iodine, the containing vessel being repeatedly shaken at intervals of an hour or so, and then allowed to repose until the following day, by which time the iodine had disappeared, and the solution was ready for use. The liquid, which had a greenish tint, was moderately diluted with water, and then electrolysed with two Daniell cells, when a film, of a blued steel colour, was promptly obtained upon a brass cathode. A single cell was next tried, when the deposit was still very rapid, of a dark colour and dull, but very adherent. After a time the solution became turbid from decomposition, and the experiment was then discontinued.

Ferrocyanide of Potassium and Iron (Soluble Prussian Blue).—A solution of this double salt was formed by adding a solution of perchloride of iron to one of ferro cyanide of potassium, the latter being in excess. The precipitate of Prussian blue thus obtained was, after filtering, dissolved in water, and the resulting liquid then gently warmed and electrolysed with a current from one, up to five, Daniells, but no deposit of iron could be obtained upon a brass cathode. The liquid was then heated to about 120deg. F., but with no better result, so the experiment was pursued no farther.

Tannate of Iron.—This electrolyte was prepared by cautiously adding a solution of tannic acid to one of perchloride of iron, avoiding an excess of the former. The black liquid thus obtained was then heated and electrolysed with the current from four Daniells, when a slight metallic film was received upon a brass plate, but only in patches, while other parts of the plate became coated with a dark brown, tolerably adherent non-metallic film. A good deal of gas was liberated at both poles, which rested on the surface of the liquid in very large bubbles, and when the cathode was lifted out of the bath these came away with it and remained for some time upon its surface without breaking, a peculiarity before observed in respect of the electrolysis of the pernitrate of iron solution. The bath was now heated, but with little or no advantage, since nothing but a trifling deposit of iron, in parts of the plate only, could be obtained, while a gelatinous deposit formed upon the plate, indicating that the solution was gradually decomposing.

Gallate of Iron.—A solution of gallic acid was gradually added to one of perchloride of iron, and the blue black liquid thus obtained was electrolysed with the current from four Daniells. The results were of a precisely similar character to the preceding, except that there was no actual film of metallic iron; the only deposit obtainable was a brown non-metallic film.

Potassio-oxalate of Iron.—A solution of this salt was prepared by Graham's method, namely, by dissolving hydrated peroxide of iron in a solution of binoxalate of potassa, a pale green solution being obtained, which was first electrolysed with a single Daniell, when an opaque, white and firmly adherent insoluble salt was deposited upon the cathode. Three cells were then tried, when a tardy deposit of metallic iron, of fairly good colour, appeared on the surface of a freshly prepared plate. The liquid was afterwards heated, and it this state it yielded a very white film of iron, which was firmly adherent. It is a singular fact that when the plate was first put into the bath after it had been heated, that the same opaque film, before noticed, at once appeared on its surface, but when the plate was allowed to rest undisturbed for a few minutes, this film disappeared, and the metallic deposit then occupied its place.

Pertartrate of Iron.—A bath was prepared from this salt by digesting recently precipitated and moist hydrated peroxide of iron in a boiling solution of tartaric acid. The resulting liquid, which, after filtration, was of a bright yellow colour, was diluted, and then tried with a current from four Daniells, when there was a brisk liberation of hydrogen, but no deposit of metal appeared on the cathode. The strength of the current was then gradually reduced, until finally a single cell was tried, but without any result. The liquid was then heated, and the experiment repeated with the same variations of current strength, but only a slight film of iron could be obtained with the warm solution, four cells being used, by briskly moving the cathode about in the bath; when stationary, no deposit whatever could be obtained. It was next determined to try the effect of dilution, as I had previously found that metallic deposits could be obtained from highly attenuated solutions of persalts of iron, which were impossible with stronger liquids. Water was now added until the bath had become diluted to about ten times its original volume. With four Daniells and increased anode surface, a bright film of metallic iron soon appeared upon a brass plate, except at the lower corners, where there was no deposit. Farther additions of water were afterwards given, a fresh plate being immersed after each addition, until the solution had become weakened to the extent of about twenty times its original bulk, when even in this very dilute condition films of metallic iron were obtained. The results of this experiment

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TABLE OF ESTIMATES.—(*See* REVIEWS on next column.)

	Unit								
No. of hours used per annum.		2000	2000	2000	2000	2000	2000	2000	2000
No. of 16 c.p. lamps in installation.		25	40	45	50	60	99	90	120
Cost of dynamo.	£	35	45	50	50	60	90	90	105
Fitting up dynamo, foundations, carriage, belting, switches, &c.	£	15	15	15	15	15	15	15	20
Nom. H.P. Otto gas engine.		2	3½	..	4	..	7	..	..
I. H.P. Otto gas engine.		4	6	..	8	..	14	..	..
Cost of Otto gas engine.	£	138	174	..	184	..	225	..	..
Cost of carriage, erection, pipes, foundations, &c., Otto gas engine.	£	32	36	..	36	..	35	..	..
Cost of wiring, installation, lamps, switches, fuses, &c.	£	50	80	90	100	120	180	180	240
Nom. H.P. steam engine (Marshall).		..	..	3	..	4	..	6	8
Cost of Marshall engine and boiler.	£	..	..	167	..	206	..	238	265
Cost of steam engine, foundations, carriage, erection, &c.	£	..	..	53	..	44	..	72	85
Cost of simple governor	£	15	15	15	15	15	15	15	15
Cost of complete governors.	£	70	70	70	70	100	100	100	100
Cost of automatic switches.	£	30	30	30	30	30	30	30	30
Cost of switch-board for accumulator and instruments.	£	40	40	40	40	60	60	60	60
Accumulator only.	£	90	162	162	180	180	243	243	243
Erection, shelves, carriage, &c.	£	10	48	48	50	50	57	57	57
Cost of installation, no accumulator.	£	270	350	375	390	445	545	595	715
Cost of installation, with accumulator.	£	415	606	630	665	720	920	970	1090
Cost of auto. installation, with accumulator.	£	515	705	730	765	850	1050	1100	1220
Average cost per lamp, no accumulator, capital account.	£ s.	11 0	9 0	8 0	8 0	7 5	6 0	6 5	6 0
Average cost per lamp, with accumulator, capital account.	£	17	14	13	13	12	10	11	9
Average cost per lamp, auto. installation, capital account.	£	21	18	16	15	14	12	12	10
Annual expense, actual outgoings, no accumulator.	£	95	124	137	148	167	230	232	292
Annual expense, actual outgoings, with accumulator.	£	103	137	150	161	180	250	252	312
Annual expense, actual outgoings, auto. installation, with accumulator.	£	106	142	155	166	185	256	258	318
Average annual cost per lamp, working expenses, no accumulator, no interest or sinking fund.	£ s.	3 16	3 6	3 1	3 7	2 15	2 9	2 9	2 8
Average annual cost per lamp, working expenses, with accumulator, no interest or sinking fund.	£ s.	4 2	3 9	3 6	3 12	3 0	2 15	2 15	2 11
Average annual cost per lamp, working expenses, auto. installation, with accumulator, no interest or sinking fund.	£ s.	4 4	3 10	3 9	3 18	3 2	2 15	2 15	2 13
Annual cost, including interest and sinking fund, no accumulator.	£	105	150	164	178	200	270	277	345
Annual cost, including interest and sinking fund, with accumulator.	£	136	184	200	214	239	322	329	401
Annual cost, including interest and sinking fund, auto. installation, with accumulator.	£	146	194	210	224	252	335	342	414
Average cost a year per lamp, with interest and sinking fund, no accumulator.	£ s.	4 4	3 15	3 15	3 12	3 7	3 0	3 0	2 16
Average cost a year per lamp, with interest and sinking fund, with accumulator.	£ s.	5 10	4 10	4 9	4 4	4 0	3 10	3 12	3 7
Average cost a year per lamp, with interest and sinking fund, auto. installation, with accumulator.	£ s.	6 0	5 0	4 10	4 10	4 8	3 14	3 15	3 9

clearly show that under certain conditions of the electrolyte—extreme dilution, apparently, being the most essential condition—solutions of iron persalts will give up their metal by electrolysis; and if this has hitherto been considered unattainable it must be evident that such necessary conditions have not been fulfilled by those who have experimented with these salts.

(To be continued.)

REVIEWS.

Management of Accumulators and Private Electric Light Installations: A Practical Handbook. By Sir DAVID SALOMONS, Bart., M.A., A.I.C.E., M.S.T.E. Third Edition, revised and enlarged. (London: Whittaker and Co.)

The third edition of Sir David Salomons' now well-known handbook is, to all intents and purposes, a new work. The number of pages in this edition has been extended from a scanty 31 to no less than 140. The style and get up of the book have at the same time been much improved, and the text is now illustrated with numerous engravings. Many readers will, however, regret to learn that the portrait of the author, which formerly graced the frontispiece, has been omitted from this edition.

The substance of the additional matter is clearly indicated by the second clause of the title, and consists chiefly of advice and instructions on the management of engines and dynamo machines. The instructions are given in the same careful and practical manner which characterises the earlier hints on the management of accumulators. The author has made it his business—as it is evidently also his pleasure—to make trials of a large number of appliances with a view to the discovery of the best possible combination of apparatus for employment in a private installation of electric light.

Sir David Salomons has always been an advocate of the employment of automatic methods of working wherever such methods can possibly be introduced with advantage, and although this must necessarily add to the original cost of the installation, yet provided that the apparatus can themselves be relied upon, there is no question as to the superiority of this style of installation in point of convenience, safety, and reliability. By the kind permission of the author we are enabled to reproduce the detailed table of estimates (pp. 138-139), giving the relative expenditure for installations of various types and sizes. (*See* preceding column).

In a fourth edition, which will probably be called for at an early date, care should, however, be taken to remove some minor blemishes which now disfigure the work, and which should for the most part have been discovered by the publishers' proof-reader. Such, for instance, as occur on pp. 72 and 73, where there are several drawings adorned with letters which are nowhere referred to in the text. Again, a few pages further on, we read with surprise that "if the engine-house is made totally inflammable there is no necessity to insure against fire."

A Scheme for Local, County, and National Government. By J. CLEGG, M.R.C.S L. (Bournemouth: Mate and Sons.)

As the question of local government reform is ripening for decision, and as electric lighting development is concerned with the form which the scheme will finally take, this little pamphlet will be found useful. The author seems to have had a large experience in the matters on which he treats.

SPECIFIC INDUCTIVE CAPACITY.*

BY J. HOPKINSON, M.A., D.SC., F.R.S.

The experiments which are the subject of the present communication were originally undertaken with a view to ascertain whether or not various methods of determination would give the same values to the specific inductive capacities of dielectrics. The programme was subsequently narrowed, as there appeared to be no evidence of serious discrepancy by existing methods.

* Paper read before the Royal Society, Nov. 17th, 1887.

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In most cases the method of experiment has been a modification of the method proposed by Prof. Maxwell, and employed by Mr. Gordon. The only vice in Mr. Gordon's employment of that method was that plates of dielectrics of dimensions comparable with their thickness were regarded as of infinite area, and thus an error of unexpectedly great magnitude was introduced.

For determining the capacity of liquids, the apparatus consisted of a combination of four air condensers, with a fifth for containing the liquid, arranged as in a Wheatstone bridge, Fig. 1. Two, E, F, were of determinate and approximately equal capacity, the other two, J, I, were adjustable slides, the capacity of either condenser being varied by the sliding part. The outer coatings of the condensers E, F, were connected to the case of the quadrant electrometer, and to one pole of the induction coil; the outer coatings of the other pair, J, I, were connected to the needle of the electrometer and to the other pole of the induction coil. The inner coatings of the condensers J, F, were connected to one quadrant, and I, E, to the other quadrant of the electrometer. The slide of one or both condensers J, I, was adjusted till upon exciting the induction coil no deflection was observed on the electrometer. A dummy was provided with the fluid condenser, as in my former experiments, to represent the necessary supports and connections outside of the liquid. Let, now, x be the reading of the sliding

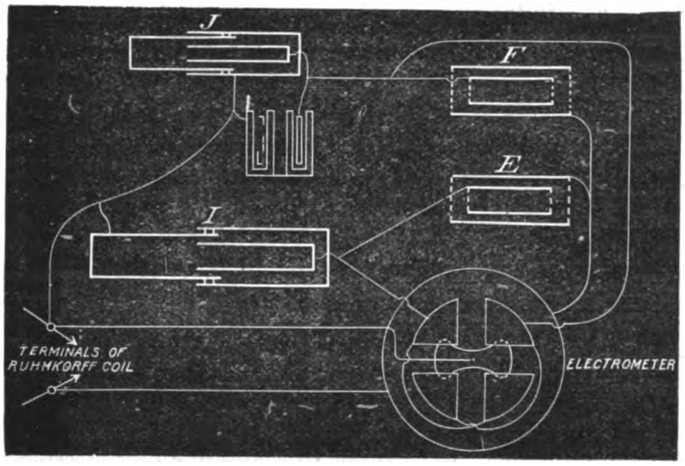

Fig. 1.

condenser when no condenser for fluid is introduced, and a balance is obtained. Let y be its reading when the condenser is introduced fitted with its dummy, z when the full condenser is charged with air. Let z_1 be the reading when the condenser charged with fluid is introduced, then will K, the specific inductive capacity of the liquid, be equal to $(y - z_1)/(y - z)$.

Three fluid condensers were employed. One was the same as in my former experiments;* another was a smaller one of the same type arranged simply to contain a smaller quantity of fluid; the third was of a different type designed to prove that by no chance did anything depend on the type of condenser. This done it was laid aside as more complicated in use.

To determine the capacity of a solid, the guard ring condenser of my previous experiments† was used. Advantage was taken of the fact that at the time when there is a balance the potentials of the interiors of all the condensers are the same. Let the ring O of the guard ring condenser be in all cases connected to J, let the inner plate of the guard ring be connected to J, as in Fig. 2, and let a balance be obtained. Let the inner plate be now transferred to I, as in Fig. 3, and again let a balance be obtained; the difference of the two readings on the slide represents on a certain arbitrary scale the capacity of the guard-ring condenser at its then distance.

In some cases it was necessary to adjust both condensers to obtain a balance; then the value of a movement of the scale of one condenser in terms of the other was known from previous experiment. In some cases it was found most convenient to introduce a condenser of capacity known in divisions of the scale of the sliding condenser coupled as forming part of the condenser J. The old method of adding the opposite charges of two condensers, then connecting to the electrometer and adjusting until the electrometer remained undisturbed, was occasionally used as a check; it was found to give substantially the same results as the method here described when the substance insulated sufficiently well to give any results at all.

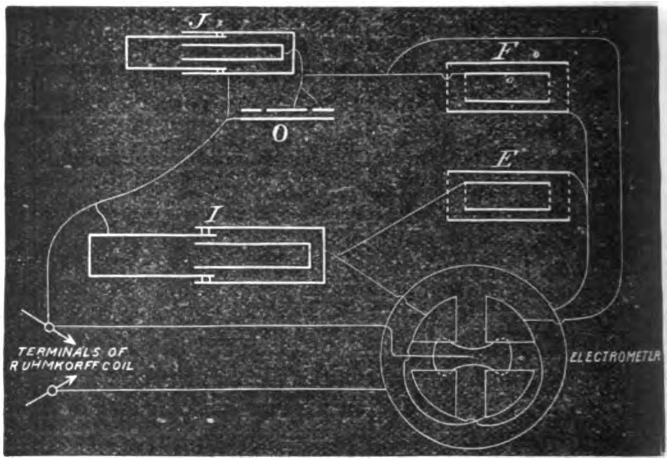

Fig. 2.

Colza Oil.—This oil had been found not to insulate sufficiently well for a test by the method of my former paper. Most samples, however, were sufficiently insulating for the present method. Seven samples were tested with the following mean results:—

No. 1. This oil was kindly procured direct from Italy for these experiments by Mr. J. C. Field, and was tested as supplied to me—

$$K = 3{\cdot}10.$$

No. 2 was purchased from Mr. Sugg, and tested as supplied—

$$K = 3{\cdot}14.$$

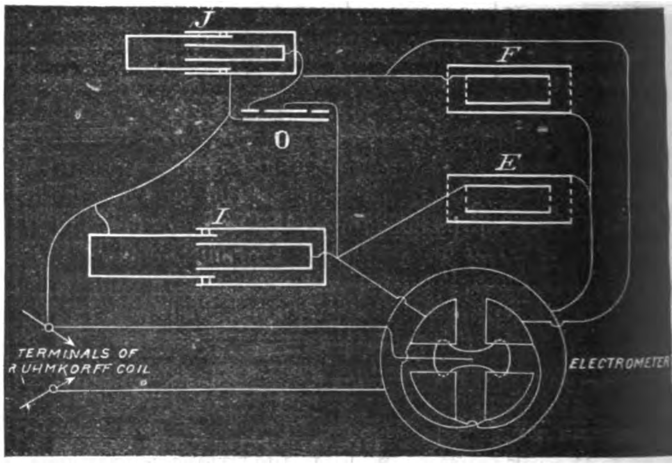

Fig. 3.

No. 3 was purchased from Messrs. Griffin, and was dried over anhydrous copper sulphate—

$$K = 3{\cdot}23.$$

No. 4 was refined rape oil purchased from Messrs. Pinchin and Johnson, and tested as supplied—

$$K = 3{\cdot}08.$$

No. 5 was the same oil as No. 4, but dried over anhydrous copper sulphate—

$$K = 3{\cdot}07.$$

No. 6 was unrefined rape purchased from Messrs. Pinchin and Johnson, and tested as supplied, the insulation being bad,

* *Phil. Trans.*, 1881, Part II. † *Phil. Trans.*, 1878, Part I.

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but still not so bad as to prevent testing—

$K = 3{\cdot}12$.

No. 7. The same oil dried over sulphate of copper—

$K = 3{\cdot}09$.

Omitting No. 3, which I cannot, indeed, say of my own knowledge was pure colza oil at all, we may I think, conclude that the specific inductive capacity of colza oil lies between 3·07 and 3·14.

Prof. Quincke gives 2·385 for the method of attraction between the plates of a condenser, 3·296 for the method of lateral compression of a bubble of gas. Palaz* gives 3·027.

Olive Oil.—The sample was supplied me by Mr. J. C. Field—

$K = 3{\cdot}15$.

The result I obtained by another method in 1880 was 3·16. Two other oils were supplied to me by Mr. J. C. Field.

Arachide.—$K = 3{\cdot}17$.

Sesame.—$K = 3{\cdot}17$.

A commercial sample of *raw linseed oil* gave $K = 3{\cdot}37$.

Two samples of *castor oil* were tried; one newly purchased gave $K = 4{\cdot}82$; the other had been in the laboratory a long time, and was dried over copper sulphate—

$K = 4{\cdot}84$.

The result of my earlier experiments for castor oil was 4·78; the result obtained subsequently by Cohn and Aron† is 4·43. Palaz gives 4·610.

Ether.—This substance as purchased, reputed chemically pure, does not insulate sufficiently well for experiment. I placed a sample purchased from Hopkin and Williams as pure, over quicklime, and then tested it. At first it insulated fairly well, and gave $K = 4{\cdot}75$, in the course of a very few minutes $K = 4{\cdot}93$, the insulation having declined so that observation was doubtful. After the lapse of a few minutes more observation became impossible. Prof. Quincke in his first paper gives 4·623 and 4·660, and 4·394 in his second paper.

Bisulphide of Carbon.—The sample was purchased from Hopkin and Williams, and tested as it was received—

$K = 2{\cdot}67$.

Prof. Quincke finds 2·669 and 2·743 in his first paper, and 2·623 in his second. Palaz gives 2·609.

Amylene.—Purchased from Burgoyne and Company—

$K = 2{\cdot}05$.

The refractive (μ) index for line D is 1·3800,

$\mu^2 = 1{\cdot}9044$.

Of the benzol series four were tested: *benzol, toluol, xylol*, obtained from Hopkin and Williams, *cymol* from Burgoyne and Company.

In the following table the first column gives my own results, the second those of Palaz, the third my own determinations of the refractive index for line D at a temperature of 17·5deg. C., and the fourth the square of the refractive index:—

			μ.	μ^2.
Benzol	2·38	2·338	1·5038	2·2614
Toluol	2·42	2·365	1·4990	2·2470
Xylol	2·39	—	1·4913	2·2238
Cymol	2·25	—	1·4918	2·2254

For benzol Silow found 2·25, and Quincke finds 2·374.

The method employed by Palaz is very similar to that employed by myself in these experiments; but, so far as I can ascertain from his paper, he fails to take account of the induction between the case of his fluid condenser and his connecting wire. He also supports the inner coating of his fluid condenser on ebonite; and, so far as I can discover, fails to take account of the fact that this also would have the effect of diminishing to a small extent the apparent specific inductive capacity of the fluid. Possibly this may explain why his results are in all cases lower than mine. Determinations have also been made by Negreano (*Comptes Rendus*, Vol. CIV., 1887, 423) by a method the same as that employed by myself.

Three substances have been tried with the guard ring condenser—double extra dense flint glass, paraffin wax, and rock salt. The first two were not determined with any very great care, as they were only intended to test the convenience of the method. For double extra dense flint glass a value 9·5 was found; the value I found by my old method was 9·896. For paraffin wax 2·31 was obtained, my previous value being 2·29. In the case of rock salt the sample was very rough, and too small; the result was a specific inductive capacity of about 18, a higher value than has yet been observed for any substance. It must, however, be received with great reserve, as the sample was very unfavourable, and I am not quite sure that conduction in the sample had not something to do with the result. In the experiments with the guard-ring condenser the disturbing effect of the connecting wire was not eliminated. My thanks are due to my pupil, Mr. Wordingham, for his valued help in carrying out the experiments.

* *La Lumière Électrique*, Vol. XXI., 1886, p. 97.

† *Wiedemann's Annalen*, Vol. XXVIII., page 474.

ELECTROMAGNETIC INDUCTION AND ITS PROPAGATION.—XLVII.

BY OLIVER HEAVISIDE.

(Concluded.)

Two non-distortional circuits of different types in sequence. Persistence of electrification, momentum, and energy. Abolition of reflection by equality of impedances. Division of a disturbance between several circuits. Circuit in which the speed of the current and the rate of attenuation are variable, without any tailing or distortion in reception.

If two non-distortional circuits of different types be joined in sequence, a wave passing along one of them will, on arrival at the junction, be usually split into two, a transmitted and a reflected wave. Let, in the former notation, V_1, V_2, V_3 denote the potential-differences in corresponding elements of the incident wave in the first circuit, the reflected wave in the same, and the transmitted wave in the second circuit. The sole conditions at the junction are that V and C shall not change in passing through it. Thus,

$$V_1 + V_2 = V_3, \qquad C_1 + C_2 = C_3 \quad . \quad . \quad (73d).$$

Now let L_1v_1 and L_2v_2 be the impedances of the two circuits, L_1 and L_2 being the inductances per unit length, and v_1, v_2 the speeds of the current. Put the first of (73*d*) in terms of the currents. Thus,

$$L_1v_1 (C_1 - C_2) = L_2v_2C_3 \; ; \quad . \quad . \quad . \quad . \quad (74d)$$

showing that the momentum of the incident disturbance equals the sum of the momenta of the reflected and transmitted disturbances. Corresponding lengths are compared, of course, proportional to the speed of the current. The condition of continuity of V is therefore identical with that of persistence of momentum.

Next, put the second of (73*d*) in terms of potential-differences. Thus,

$$S_1v_1(V_1 - V_2) = S_2v_2V_3 \; ; \quad . \quad . \quad . \quad . \quad (75d)$$

which expresses that the electrification suffers no loss by the splitting. The condition of continuity of C is therefore equivalent to that of the persistence of electrification.

Multiply the first of (73*d*) into (75*d*); the second of (73*d*) into (74*d*); the two members of (73*d*) together; and (74*d*) into (75*d*). The results are

$$\left. \begin{array}{c} S_1v_1(V_1^2 - V_2^2) = S_2v_2V_3^2 \; ; \quad L_1v_1(C_1^2 - C_2^2) = L_2v_2C_3^2 \; ; \\ V_1C_1 + V_2C_2 = V_3C_3 \; ; \end{array} \right\} \quad (76d)$$

which are equivalent expressions of the fact of persistence of energy, while the last of (76*d*) is the equation of transfer of energy. That it should be equivalent to the others will be understood on remembering that the energy is transferred at speed v_1 or v_2, according to position.

We have, therefore, three things that persist, electrification, momentum, and energy, and these are expressed most simply by the two equations (73*d*) and by their product. If the continuity of V could be violated at the surface across the

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dielectric common to the two circuits at their junction, there would be a surface magnetic current; and if the continuity of C could be violated, there would be a surface electric current. These statements are implied in the general equations

$$-\text{curl}\,E = 4\pi G, \qquad \text{curl}\,H = 4\pi\Gamma, \quad . \quad . \quad (77d)$$

where E and H are the electric and magnetic forces, Γ and G the electric and magnetic currents. That is, tangential continuity of E implies normal continuity of G (or of the induction, since it, like G, can have no divergence); and tangential continuity of H implies normal continuity of Γ, and therefore, in our special case, of electrification. In fact (73*d*) express the same facts as (77*d*) do generally.

Now the continuity of V and C is violated at the boundaries of an isolated disturbance (*e.g.* V = constant in a certain part of the circuit, and zero before and behind). Then we do have the surface electric and magnetic currents on the front and back of the disturbance. It should, however, be stated that the conception of an isolated disturbance is merely employed for convenience of description and argument. Practically, there cannot be abrupt discontinuities; we must make them gradual. Then the surface currents become real, with finite volume-densities.

The ratio of the reflected to the incident wave is given by

$$V_2/V_1 = (L_2v_2 - L_1v_1)/(L_2v_2 + L_1v_1), \quad . \quad . \quad (78d)$$

and is positive or negative according as the impedance of the second circuit is greater or less than that of the first. The abolition of reflection is therefore secured by equality of impedances, irrespective of any change of type that does not conflict with this equality. Every element of the transmitted wave therefore carries forward, in passing the junction, its potential-difference, current, electrification, momentum and energy unchanged, but is changed in length in the same ratio as the speed of the current is changed.

In a similar manner we can determine fully what happens when a disturbance travelling along one non-distortional circuit is caused to divide between any number of others of any types. We have merely to ascertain the magnitude of the reflected wave in the first circuit. Let V_1 and U_1 be the incident and reflected waves. Then, corresponding to (78*d*) we shall have

$$U_1/V_1 = (I - L_1v_1)/(I + L_1v_1), \quad . \quad . \quad . \quad (79d)$$

where I is the resultant impedance of all the other circuits (instead of L_2v_2, that of one only), viz. the reciprocal of the sum of the reciprocals of their separate impedances. Knowing thus U_1 in terms of V_1, we know their sum. But this is the common potential-difference in all the transmitted waves, which are therefore known, since by dividing by the impedance of any circuit we find the current. As regards the attenuation as the disturbances travel away from the junction, that must be separately reckoned for each circuit, according to the value of R/L, in the way before described. There will be found to be the previously mentioned persistences, provided all the waves are counted, including the reflected in the first circuit.

Now put any number of non-distortional circuits in sequence. If their impedances be equal, we know, by the above, that a disturbance will travel from end to end without any reflection at the junctions. It will vary in its length and in its speed, and also in the rate at which it attenuates, but there will be no tailing, however many changes there may be in the values of R and L. By pushing this to the limit, we arrive at a circuit in which R and L vary in an arbitrary manner, (functions of *x*), whilst K varies in the same way as R, and S in the same way as L. The impedance is a constant, but the rate of attenuation and the speed vary in different parts of the circuit.

If we start an isolated disturbance at one end, it will travel to the other without tailing. But it will be distorted on the journey, owing to the variable speed of its different parts and the variable attenuation. But as regards the reception of the wave, there is no distortion whatever. For, on arrival at the distant end, where we may place the absorbing resistance, every element of the wave has gone through the same ordeal precisely, passing over the same resistances in the same sequence and at the same speed at corresponding places, so as to arrive at the distant end in the same time, attenuated to the same extent. Similarly there is no intermediate distortion as regards the succession of values of V and C at any one spot. There is only distortion when it is the wave as a whole that is looked at, comparing its state at one instant with that at another. And if we should cause this wave to start in a uniform circuit, then pass into an irregular one as just described, and finally emerge in a uniform circuit again, it will have then recovered its original shape, every part being attenuated to the same extent.

As regards the time taken to pass over a distance *x* in the variable circuit, we have to solve the kinematical problem: given the path of a particle, and its speed at every point, find the time *t* taken. Thus,

$$t = \int dx/v,$$

taken between the proper limits, wherein *v* is to be a function of *x*. The attenuation suffered in this journey is more easily expressed. Go back to the former case of any number of uniform non-distortional circuits of equal impedance joined in sequence. The attenuation produced in passing through any number of them is the product of their separate attenuations, *i.e.*,

$$\epsilon^{-R_1/Lv} \times \epsilon^{-R_2/Lv} \times \ldots = \epsilon^{-\Sigma R/Lv}, \quad . \quad . \quad (80d)$$

where R_1, R_2, . . . , are the resistances of the separate sections, and *Lv* the common value of the impedance. As this is independent of the number of sections or their closeness, we see that in our variable circuit the attenuation in any distance is expressed by the right member of (80*d*), wherein ΣR represents the total resistance of the circuit in that distance, or $\int R dx$ between the proper limits, R being a function of *x*.

The above given demonstration of the properties of the variable non-distortional circuit, which is rather a curiosity, depends entirely upon our previous proof that the abolition of reflection at the junction of a pair of simple non-distortional circuits is obtained by equality of impedances irrespective of any change that may take place in the resistances. The following is also of some use. Go back to the fundamental equations

$$-\nabla V = (R + Lp)C, \qquad -\nabla C = (K + Sp)V; \quad . \ (81d).$$

wherein ∇ means *d/dx*, and *p* means *d/dt*. Now *assume* V = *Lv*C, making them become

$$\left.\begin{aligned} -\nabla(LvC) &= L\,(R/L + p)\,C, \\ -\nabla C \quad &= S\,(K/S + p)\,(LvC). \end{aligned}\right\} \quad . \quad . \quad (82d).$$

If our assumption can be justified, these equations must become identical. They do become identical if R/L = K/S, and *Lv* = constant; becoming

$$-v\nabla V = (R/L + p)V. \quad . \quad . \quad . \quad . \quad (83d)$$

This is for the positive wave. The assumption V = − *Lv*C again makes (81*d*) identical under the same conditions, the resulting equation being (83*d*) with the sign of *v* changed. The necessary conditions may be written

$$R/K = L/S = (Lv)^2 = \text{constant}; \quad . \quad . \quad (84d)$$

and since we have made no assumption as to the constancy of R, L, K, and S, we see that R and L are left arbitrary, any functions of *x*. Or, what comes to the same thing, R/L and *v* are arbitrary, making the attenuation and the speed variable, but without any tailing.

A third way is to examine what happens when we place a bridge of conductance *k* across the junction of two non-distortional circuits of different types but of the same impedance, along with a resistance *r* in the circuit at the same place. The two conditions, using the former notation, are

$$\left.\begin{aligned} V_1 + V_2 &= (1 + r/Lv)V_3, \\ V_1 - V_2 &= \{1 + (k/Sv)(1 + r/Lv)\}V_3; \end{aligned}\right\} \quad . \quad . \quad (85d)$$

from which

$$\left.\begin{aligned} V_1/V_3 &= 1 + r/2Lv + (k/2Sv)(1 + r/Lv), \\ V_2/V_3 &= r/2Lv - (k/2Sv)(1 + r/Lv), \end{aligned}\right\} \quad . \quad (86d)$$

which give the ratios of incident and reflected to transmitted wave. We destroy the reflection by

$$r/Lv = k/Sv + rk,$$

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and then the attenuation is

$$V_3/V_1 = (1 + r/Lv)^{-1}$$

due to r and k. An infinite number of these r's and k's in succession, placed infinitely close together, leads to the expression (80*d*).

We can also go a little way towards finding what occurs when the only condition is Lv = constant, so that there is tailing. For we then have, at a single junction

$$V_3/V_1 = (1 + r/2Lv)^{-1}(1 + k/2Sv)^{-1} ;$$

and therefore, when the distribution of r and k is made continuous, the attenuation of the head of a disturbance in passing through any distance is

$$\epsilon^{-R_1/2Lv} \times \epsilon^{-K_1/2Sv},$$

if R_1 be the total resistance and K_1 the total conductance of the leakage in that part of the circuit. But we cannot similarly estimate to what extent the total charge and momentum have attenuated, as we could when the circuit was uniform, because the attenuation now occurs at a different rate in different parts of the tail, and we are not able to trace the paths followed by the different parts of a charge as it splits up repeatedly. The determination of the exact shape of the tail is of course an infinitely more difficult matter. But an approximation may be obtained by easy numerical calculations, if we concentrate the resistance and leakage in a succession of points.

P.S. to Section XLVI.

CORRECTIONS. By an oversight, the corrections to the proof of Section XLVI. (October 7, 1887) were not carried out. The following are necessary :—

Page 459, 2nd column. In second line after equation (60*d*), for V_2V_1 read V_2/V_1. Equation (62*d*), for V_1V_3 read V_1/V_3.

Page 460. In third line of second column, for n read x. In eighth line after equation (67*d*), for r read r. Four lines later, for t S/K read S/K. In equations (69*d*) and (70*d*), for V_α read V_0a ; also in second line before (69*d*). In (70*d*), for n read x.

NOTE (Nov. 30, 1887).—The author much regrets to be unable to continue these articles in fulfilment of Section XL., having been requested to discontinue them.

SOUTH KENSINGTON.

EXAMINATIONS OF THE SCIENCE AND ART DEPARTMENT.

(*Continued from page 17.*)

Voltaic Electricity.

30. When a coil of wire is connected in circuit with a battery and a tangent galvanometer, the galvanometer shows a deflection of 45°. If the wire is replaced by resistances of 24 and 25 ohms in turn, the deflection is 46° in the first case and 44° in the second. Find the resistance of the wire.

Tan 44° = 0·966 ; tan 45° = 1·000 ; tan 46° = 1·036.

Answer. Let r be the required resistance of the wire, and R that of the battery and connections; then, if the E.M.F. of the battery be supposed to remain constant, we have

$$\frac{E}{R+25} : \frac{E}{R+r} : \frac{E}{R+24} = \tan 44° : \tan 45° : \tan 46°$$
$$= 0·966 : 1·000 : 1·036,$$

which give

$$\frac{R+r}{R+25} = \frac{0·966}{1·000}$$
$$\frac{R+r}{R+24} = \frac{1·036}{1·000} ;$$

or,

$$0·034\,R + r = 24·150,$$
$$-0·036\,R + r = 24·864.$$

Whence by subtraction $\quad ·07\,R = -·714$;

or, $\quad R = -10·2$

The battery resistance would therefore have to be negative in order to fulfil the conditions of the problem, and this would, of course, be practically impossible. But a question of this kind forms a somewhat severe test of a candidate's confidence in his work, as if he were doubtful about the correctness of his method he would naturally conclude that such a result was due to some error on his own part.

Substituting the value obtained for R in one of the equations connecting r and R, say

$$0·034\,R + r = 24·15,$$

we obtain $\quad -0·3468 + r = 24·15,$

or $\quad r = 24·4968$ ohms.

31. A current is passed through a coil of wire and through a voltameter arranged in series with it. If the strength of the current is altered so that the heat produced per minute in the coil of wire is doubled, show what change will be produced in the rate at which chemical action takes place in the voltameter.

Answer. Let H_1 and H_2 be the quantities of heat produced in the two cases by the currents C_1 and C_2 respectively. Then since the amount of heat produced is proportional, other things being equal, to the square of the current strength, we have

$$\frac{C_1^2}{C_2^2} = \frac{H_1}{H_2} = \frac{1}{2}.$$

Therefore $\quad \frac{C_1}{C_2} = \frac{1}{\sqrt{2}}.$

And the rate at which chemical action takes place is proportional to the current strength, so that the ratio of the rate of chemical action in the second case to that in the first case will be as $\sqrt{2} : 1$.

32. If an increase of the resistance of a circuit by 10 ohms causes the strength of the current to decrease from 5 to 2, find the total resistance of the circuit after the change.

Answer. When the E.M.F. remains constant, the current strength is inversely proportional to the resistance, so that if r be the original resistance of the circuit in ohms, we have

$$\frac{r+10}{r} = \frac{5}{2},$$

which gives $\quad r = 6.\dot{6}.$

And therefore $r+10$, the total resistance after the change, is equal to 16·6.

33. Two bars of bismuth A and B are attached to the extremities of a bar of antimony, and a current is passed from A to B. Is there any difference, and, if so, what, between the effects produced at the two junctions? How does the effect in each case depend on the strength of the current?

Answer. Let the current from the battery r flow through the system of bars from A to B, as shown in Fig. 28. Then the junction C, where the current flows from bismuth to antimony, will be cooled by the passage of the current, while the junction D will be heated by the passage of the current from antimony to bismuth, this is known as the Peltier effect. The effect at C will be less than the true amount due to the Peltier effect, and that at D will be greater owing to the heat produced in the ordinary way by the resistance of the circuit. The Peltier effect at either junction is approximately proportional to the strength of the current, and the heat due to resistance will, when the current is increased, increase in the ratio of the square of the current.

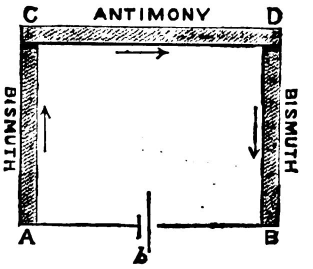

FIG. 28.

34. A piece of wire is bent into the form of a rectangle, and the ends are joined. It is laid upon a horizontal table with two sides pointing magnetic north and south. If the rectangle be turned about the east side as a hinge so as to lie on the table to the east instead of to the west of it, what will be the direction of the

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current which circulates in the wire during its motion in consequence of the earth's magnetism ?

Answer. Let the rectangle A B C D (Fig. 29) be laid on a horizontal table, with its sides C A, D B, pointing magnetic north and south, as shown in the diagram. If it be turned about the east side B, D, as a hinge, a momentary induction current, due to the earth's magnetism, will flow along the hinge from north to

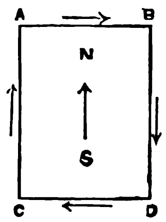

Fig. 29.

south, or the current round the rectangle will be in the direction A B D C, as shown by the arrows.

(*To be continued.*)

ELECTRICITY IN MEDICINE.

[A COMMUNICATION.]

Electricity as a therapeutic agent in medicine and in surgery has now gained an acknowledged place.

Electropathy, at first only timidly courted by medical men, was apt to be looked upon but a few years ago as the practice of an occult art. Little was known about electricity—spoken of indifferently as a current, a fluid, or an imponderable agent—not much of its effects or influence, nothing whatever of its mode of action as a curative agent. If even yet we may not be quite certain as to what electricity really is, or of the extent of its curative powers, or, again, of its mysterious beneficial action in health or disease, we cannot but acknowledge that electropathy has made giant strides of late. It may now, indeed, be classed as an exact science ; for, after all, what if we do not know the actual way in which the electric current works on the human system ? Are we not quite as much in the dark on this head, at least with regard to many, if not most drugs? It is only just beginning to dawn on the profession why and how alkaloids—vegetable or animal—so powerfully affect the living organism. The time, perhaps, may come when we shall know all about electricity ; but in the meantime we know that electricity does act beneficially in many cases. So far as this goes we have plenty of evidence in support, and for the moment this should suffice us—sufficient, at least, to make us adopt it as a useful servant, while we grope diligently into its history, and endeavour to grasp more accurately and definitely the mystery as yet hidden from us. There is a great secret unguessed, but we need not despair of, sooner or later, wresting it from Nature.

There was a time, and no distant one either, when the use of electricity by physician or surgeon was undoubtedly dangerous. There was a distinct difficulty in prescribing accurate doses ; the strength of each battery differed, and was by no means regular in its action, and it was, moreover, impossible to measure or regulate the force of the current. All this is changed. Batteries are more perfect in make, their action more steady and regular, and we possess the galvanometer. Hence, definite doses may be prescribed and accurately administered. An exact method of computation has been established, and now the operator, armed with one of the new instruments with all its modern improvements, may regulate at his will, graduate the flow, and operate with the utmost precision. The patient's sensations are no longer the sole or even the principal guide to the operator. They need only be taken into consideration as a useful index of the patient's susceptibility to electricity.

At first merely valued as a means of diagnosis in death or paralysis, it is now known as a remedy in many maladies. Its inestimable use in muscular and nervous derangements is now no longer questioned. It is a *stimulating* and a *sedative tonic*, for it stimulates the action of the nerves and muscles, promotes nutrition, and stills pain. Electricity will act as a stimulant where all other specialities have failed ; so, too, will it happily replace anodynes when they have been tried in vain, for in the hands of a skilful practitioner it is a powerful and speedy soother.

Adopted as a remedy in great evils and in small ones, it frequently answers all expectations. Of paralysis it has been said, "If the paralysed muscles retain their electro-contractility and sensibility, and so show that they have not passed into that state of fatty degeneration into which they always tend to pass eventually, there appears to be scarcely any limit to the time in which improvement and even complete recovery is possible." Then let us pause and consider its wonderful efficacy in neuralgic disorders as a reliever of mental and bodily depression and fatigue. But electricity is general in its action, it does not merely affect the muscular and nervous systems. Coming to smaller matters, we hear of its dissipating chilblains. The Americans have invented and widely adopted a mechanical electro-massage instrument with very marked beneficial results.

In surgery what has not been done with electricity ? We have the cautery heated only after it is properly and safely placed, and kept at a uniform heat during the whole duration of the operation. Then the knife, the *ecraseur* or loop, and the needles—all and each one of these instruments having the same great advantages attached to their use as that so noticeable in the electric cautery. In delicate operations, where hemorrhage is looked for and dreaded, electricity is invaluable, for whether the knife or the *ecraseur* be employed, the flow of blood is often entirely prevented, and always materially diminished—undisguised blessings which every surgeon will recognise.

Although many advocates of electropathy are apt to push their views too far—for we by no means recognise the use of electricity on every occasion as a sort of universal agent, either in medicine or surgery—yet we think that a great future lies before the really scientific medical electrician, who, while deeply imbued with the importance of his study, at the same time avoids its indiscriminate use. So much has already been done, and in so remarkably short a lapse of time, that careful experiments and diligent observation and study cannot fail to enhance the medical value of this mysterious but undoubtedly beneficial agent.

TESTS OF THE JULIEN ACCUMULATOR.*

BY GEORGE B. PRESCOTT, JUN

The following electrical measurements of the Julien accumulator were made in order to determine its adaptability to a certain class of work, and to that end it has been sought to ascertain with as much accuracy as possible its precise rate of doing work, the total amount which it is capable of performing, and its efficiency under various conditions as a transformer of energy. For this purpose I employed five of the standard cells of the following dimensions, as determined by my own measurements, viz.:—

Weight of cell complete	38lb.
,, grids and active material	27·5lb.
,, electrolyte	4 5lb.
,, glass containing jar	6lb.
Number of positive plates	9
Dimensions ,, ,,	$5\frac{13}{16} \times 5\frac{13}{16}$lb.
Active surface of positive plates	4·25 sq. ft.

Three of the above cells were furnished directly from the works, especially for this test, and the remaining two were received from the works at the same time by Mr. Weston. These latter were incorporated into this test, as it was deemed that greater accuracy could be attained by the use of a larger number of cells. It is assumed, of course, that all were thoroughly formed and in prime condition.

Three of the cells were filled with dilute sulphuric acid (free from nitric acid), of the density of 15deg. Baumé ; the electrolyte of the remaining two cells had a density of 23deg. Baumé. The degree of density of the electrolyte had no perceptible influence upon the E.M.F. of the accumulators, and the conditions of the test were such as to make it inconvenient to determine whether the regularity of discharge was influenced by this condition.

The cells were charged by a Weston dynamo driven at a uniform speed, and were discharged through German silver wires adjusted to suit the required conditions. E.M.F. and potential difference (P.D.) were measured by means of a white pattern Thomson quadrant electrometer, standardised by Weston-Clark standard elements. All readings are given in legal units, and time was accurately noted. Current was measured by a magnet ammeter, reading to within two-tenths ampere, which was carefully calibrated at the beginning of the test.

The cells were never discharged at a rate exceeding 30 amperes, as that was the limit of reliable reading on the ammeter ; but the general results are such as to indicate that the normal output of these cells should not be allowed to exceed that rate if anything like a reasonable efficiency is desired. No doubt this output may be momentarily increased up to 40 or 50 amperes without immediately endangering the stability of the cell, but such increase will always be obtained at a large sacrifice of its efficiency.

Five complete tests—charge and discharge—were made, the

* From the New York *Electrician and Electrical Engineer.*

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TESTS OF THE JULIEN ACCUMULATOR.

Test No.	Charge or discharge.	Time hours.	Mean P. D. at cells. Volts.	Rate.		Total.		$\frac{C_t E t_t}{C E t}$ %	$\frac{C_t t_t}{C t}$ %	$\frac{C_t}{C}$ %	Fall in potential. %	Time between charge and discharge. Hours.
				C amperes.	$C E$ watts.	$C t$ Ampere hours.	$C E t$ Watt hours.					
1.	Charge.	6·25	11·76	17·6	205·3	110·	1283·					
1.	Discharge.	4·59	10·12	19·23	194·6	88·3	893·7	69·7	80·3	109·3	9·	15
2.	Charge.	8·17	11·9	18·07	215·	147·7	1755·8					Interval of 14 hours.
2.	Discharge.	3·72	10·09	28·86	291·2	107·3	1083·2	61·7	72·6	159·7	8·	2 + 15
3.	Charge.	8·	12·13	18·08	219 4	144·6	1755·2					
3.	Discharge.	3·55	10·14	29·47	299·	104·6	1060·8	60·5	72·3	163·	11·	16
4.	Charge.	9·	12·	18·01	216·2	162·9	1955·3					
4.	Discharge.	3·53	10·13	29·8	301·9	105·13	1065·8	54·5	64·3	165·4	15·	15½
5.	Charge.	5·11	11·58	22·1	255·9	112·75	1305·8					
5.	Discharge.	11·83	10·3	10·23	105·3	121·15	1247·7	95 5	107·	46·3	8·3	15¾

results of which are given in the accompanying table. The significance of these figures is so obvious that I hardly need to point out to you the general conclusions to be drawn therefrom.

The first charge was discontinued about one half-hour after gas began to be freely evolved from the cells, and the rate of charging was approximately that given by the makers, viz., 18 amperes. The discharge was maintained at about 20 amperes, and the test showed a return of nearly 70 per cent. of the total energy absorbed. The second and third tests were also made at the normal rate of charging, which was, however, carried to a higher point than in the first test, and continued for a longer period after gas began to be evolved. They were discharged at the rate of about 30 amperes, and while a somewhat greater output was shown over the preceding tests, the energy returned fell off to 61 per cent. In the fourth test the charging was accomplished at the normal rate, but was continued for several hours after the evolution of gas, and until nearly 400 watt-hours of energy had been expended in each cell. The total output thereby obtained did not, however, exceed that of the preceding tests in which much less work had been done in charging—the efficiency falling to 54 per cent.—thereby clearly indicating that the limit of charge is not much over 300 watt-hours per cell. The output might be slightly increased by increasing this charge at a low rate, but under the necessary practical conditions of quick charging, any increase would be obtained at such an enormous loss that it would be, commercially, out of the question.

The fifth and last test was carried out without special regard to makers' instructions, although, with the exception that the density of the current was greater, the general effects were about the same as if the cells had been charged at constant potential. The charging current was kept at 26 amperes until there was a mild evolution of hydrogen, and then gradually decreased so as to maintain the evolution of gas about constant. When the current had thus been reduced to 10 amperes it was allowed to stand at that strength until the gas began to be freely evolved, when the charge, according to my belief—having reached its economical limit, was discontinued. The evolution of gas represents the expenditure of energy, and as it is dissipated beyond the reach of recovery such evolution means direct loss, and the charge cannot be carried beyond that point without a corresponding loss in the efficiency of conversion. I have not seen this point noted in any of the numerous papers on accumulators which I have read, but I assume that it must be obvious to every one. The high efficiency of 95 per cent. shown by this last test is chiefly due to the low rate of discharge, which never exceeded 10 amperes, but was largely increased by the discontinuance of the charge at 260 watt-hours before the loss of much gas. It was, no doubt, still further raised by the cells having recovered somewhat from the previous discharge, which had been effected at a high rate, and thus an abnormally large output was obtained, although discharged to the same potential in both cases. That is to say, when the cells are discharged at a high rate their potential falls suddenly to the normal limit. When discharged slowly the potential falls gradually to the limit. In the former case, after remaining open for a while, there was considerable recovery, as illustrated by redischarge, whilst in the latter case there is hardly any. Therefore, it would appear that the efficiency given for test No. 5 is higher than its true efficiency, owing to an excess of residual charge that could not be easily allowed for.

The effect of lapse of time between the charging and discharging of the accumulators could not be accurately determined without extending the tests for a considerably longer period of time. The difference in loss of efficiency between an immediate discharge and one after the lapse of fifteen or twenty hours (see tests 2 and 3) is, however, very small, although if the cells are not thoroughly insulated it might amount to considerable.

From the figures of the tests and the preceding considerations it is obvious that almost any degree of efficiency may be obtained from these accumulators. In fact, it is well known that the maximum efficiency of any accumulator is attained when the rate of charging and discharging is a minimum ; in other words, when the power expended or rate of doing work is a minimum. It is therefore necessary to adopt some standard working rate for these cells, and then determine their capacity and efficiency on the basis of this rate of working. The normal output of the cells should not—as already determined—exceed 30 amperes, and as the average E.M.F. of the cells is about two volts, it is obvious that the average rate of working must not exceed 60 watts per cell. At this rate the capacity of the cells will not exceed 110 ampere-hours (see tests), and as the average P. D. during discharge is 2·03 volts, the total work done by each cell will not exceed 225 watt-hours.

Again, considering the figures of the tests, and taking into account the system of working the accumulators which you have in view, their efficiency at the above rate of working will be somewhat between 60 and 70 per cent. For ordinary working on the assumption that abnormally large discharges will be balanced in effect by abnormally small ones, the efficiency of the accumulators will probably closely average 65 per cent., and I think this figure a safe one to estimate upon.

On the above basis the following figures are self-explanatory : —

For a Single Cell.

Rate of working	0·0804 h.-p.
Time of working at this rate	3·75 hours.
Total work..	0·3016 h.-p.
Battery per horse-power hour	126lbs.

Thus 38 cells will weigh 1,444 pounds, and will develop 11·46 horse-power hour, which, expended at the rate of 60 watts per cell, is equal to three horse-power for 3·82 hours. Any loss in secondary conversion must, of course, be deducted from these values.

As to the permanency of the cells, both as regards mechanical durability and electrical efficiency, time alone can report.

"A TALK ON TRAMWAYS."

At the meeting of the New York Electrical Society, held on November 30, Mr. Holroyd Smith gave a "Talk on Tramways," in which he treated the subject of street railroads first in a general way, and then with special reference to the electrical method. In beginning his address, Mr. Smith said that too much attention cannot be given to the fact that in electrical railroading the electrician occupies the second place to the engineer, and that the past failures in electrical railroading have been due to the fact that electricians, pure and simple, have gone into the domain of engineering without sufficient knowledge to guide them. In other words, the electrician must not expect to succeed in working tramways unless he studies the engineering problems as well. Mr. Smith, in taking up the subject generally, drew attention to the fact that American railroads, or tramroads, were the necessary outcome of the generally bad ordinary roads, whereas in England the roads are uniformly good. While in America the centre bearing rail is employed almost universally, in England and abroad generally such a rail would not be permitted, and recourse must be had to the grooved rail. Hence, while with American cars and rails the coefficient of traction amounts to about only 8lb. to the ton, the English rail requires 23lb. to the ton, so that these things must not be lost sight of in designing cars. It will thus be seen that conditions vary considerably in different countries, even when seemingly they are quite alike. Mr. Smith asserts that the increased power claimed for the driving motors is due to the over-estimation of the power required to move the car.

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Mr. Smith then entered into the consideration of traction by horses, compressed air, steam and cable, and deplored the fact that while in England the statistics of running expenses of horse-car lines were well-known and published in Duncan's *Tramway Manual*, we had no such source of information, and it was with the greatest difficulty that any reliable figures could be obtained with regard to the subject on American lines. Mr. Smith stated that as a rule in England a 2-horse car running for 14 hours a day required 10 horses. These horses cost £30, and had an average life of three years. In discussing the question from the electrical standpoint, Mr. Smith drew attention to three essential points that have to be considered :—1. Safety to the public. 2. Efficiency. 3. Economy.

Taking up the storage battery first, Mr. Smith held the position that even if the battery could be successfully worked, it would cost one-third more to equip and run a line on this system than to put down a conduit, and especially would this be the case where traffic is very heavy. Mr. Smith was of the opinion that of the various systems the overhead system was the best, taking all into consideration ; but the great danger in its use lay in the tendency to do slipshod work. The difficulties met with at crossings and switches in railway work where conductors of opposite polarity met in a horizontal plane are overcome by placing the conductors in a vertical plane, so that even if contact does occur it can only happen between two positive or two negative conductors. Mr. Smith finally described a new method of his own which was designed to overcome all the objections to both the overhead and underground circuits, and which, without the use of the storage battery, is arranged to supply the motor on the car with electricity. This system, which was only hinted at by the speaker, will no doubt attract some attention in the future.

In the discussion which followed, Mr. T. W. Rae spoke of the experiments made on cars in this city by Mr. C. E. Emery, the well known engineer, who found that the coefficient of traction was 12½lb. per ton ; and General Q. A. Gilmore states that the general average for the whole country is 16⅔lb. per ton.

Mr. R. G. Blackwell, whose opinions on this subject are well known, deprecated the use of the storage battery entirely, and, in replying to a question, remarked that the delay in the construction of the Fulton-street road in this city, undertaken by the Bentley-Knight Company, was due to legal complications ; and that all the material required for the road was in store in this vicinity, ready to be applied at the earliest notice.

Mr. C. O. Mailloux, in replying to Mr. Blackwell, detailed the experiments which are now going on upon the Madison Avenue line in this city on a car equipped with 120 cells of Julien storage battery, and which ran from 85th-street to Harlem Bridge and back, on a run of 40 miles, with a drop of but two volts. Mr. Mailloux stated that the Brussels Tramway Company are now operating 10 cars of this system, and that before many months have elapsed New York will see as many storage cars in operation. Mr. Mailloux drew special attention to the fact that storage batteries were well adapted to long lines on account of the large conductors required with the overhead and underground systems, where the drop of potential has to be made as small as possible.

Mr. Holroyd Smith confirmed this statement of Mr. Mailloux, but he still claimed that the use of the storage battery was only a transient one. In reply to a question by Mr. Davidson as to whether a conduit had ever been operated in this country, Mr. R. G. Blackwell referred to the experimental line operated in Cleveland on the Bentley-Knight system, and carried on through snow, ice, and water without trouble. Mr. Smith also confirmed this fact, and stated that the last winter had been most severe in Blackpool, England, where his road was in operation ; but notwithstanding this, the current had practically not stopped in three years since the road went into operation.

THE LIGHTING OF THE GRAND CENTRAL RAILWAY STATION IN CINCINNATI.

A COMPARISON OF GAS AND ELECTRICITY.

The following report has been furnished by Mr. J. W. Hill to the President of the Cincinnati Gaslight and Coke Company :—

I have the honour to submit herewith a complete detailed report of the results obtained from the recent test of the Edison electric light plant at the Grand Central Station in this city. As the compilation of the results appears quite voluminous, and may prove a little tiresome to follow out in all its details, I thought it best to submit with it this summary.

The test covered an interval of sixteen days ; the first eight being assigned to the Gas Company, and the second eight (of which I had special charge) from 6 a.m. October 11 to 6 a.m. on October 19, or 192 consecutive hours. During the whole of this time careful observations were made of the lights in service, the average illumination power of the lights, the power required to produce the light, and the cost of its production.

During this test the steam used for operating the elevator pumps, and that for heating the buildings was taken from a separate set of boilers, leaving one battery to be used exclusively in furnishing steam to the engines used in driving the dynamos, and the cost of which was found to be as follows :—

Coke used (including fuel to start fires every two weeks) 929 bushels, at 7c.	$65	03
Water to boilers, including waste to sprinkle ashes and clean boilers, 38,408·16 galls., at 9c. per 1,000 galls.	3	46
Wages, two firemen, one day and one night, at $45 per month	23	68
Interest on investment and depreciation of boilers and fixtures	9	86
Total cost of steam supplied for eight days...	$102	03

In order to ascertain the cost per annum, it is necessary to determine the ratio of lighting hours which these eight days bear to the entire year. Both the bills rendered for electric lighting and the lighting time table of the gas company show the dark hours of October to be one-tenth of the entire year, which, taken as the basis of calculation, make the actual cost of steam for one year supplied by the Depot Company $3,879.30.

The charge for electric light, exclusive of steam supply, is based upon the weight of zinc, in grammes, deposited during any interval of time, multiplied by the constant 17, which gives the number of so-called "thousand candle-power" of light furnished for the interval, and for which they are, according to their contract, authorised to charge 45c. per so-called "thousand candle-power," which charge is equivalent to $7.65 per gramme of zinc transferred during eight days. The weight of zinc thus deposited—as weighed and reported by the Electric Light Company—was 21.829 grammes, which at $7.65 per gramme equals $167 for eight days, or $647.12 for the month of October, or a total cost per annum (exclusive of steam) of $6,471.25. This discrepancy between the cost, as shown by the test, and the previous actual charge made to the Depôt Company cannot be reconciled by any possible change of conditions, or any known method of computation, and certainly shows that either during this test some method was successfully adopted with a view of materially reducing the apparent cost of electricity, or that the charge heretofore made for an equal degree of illumination has been disproportionate to the service rendered ; for I am informed that for the month of October, 1886, the charge made was $926.06, and for the year $10,784.82—making the total expense of one year's electrical illumination of the depot, according to this test, $10,350.55; and according to the actual amount charged for 1886 by the Electric Light Company, $14,664.12. The average illumination of all the lights in service at the depot buildings, train shed, omnibus court, along the tracks west of the depot, and in the office and stables of the American Express Company, was equivalent to 185 15 light of 16 actual candle-power each, or 2962·4 candles. Prof. French's test of the Cincinnati gas shows it to be of 16·94 candle-power. An equal degree of illumination of gas—2962·4 candles—would require the use of 167880·86 cubic feet, which at $1.15 per 1,000 feet equals $193.06 ; or for October, $748.11 ; or for one year the total expenses would be $7,481.10.

The total registered quantity of gas actually passing the meters during the eight days' test was 214,700 cubic feet, of which 16,000 cubic feet (it is stated) was used by "thief lights" of old style lamps ; leaving the amount actually used for illuminating purposes 196,700 cubic feet, which at $1 15 equals $228.50 ; for October, $885.44 ; or for one year, $8,854.40. This shows, first, that the same degree of illumination can be obtained with gas that was given by electricity, during the recent test, with a saving of $2,869.45, or 27·72 per cent. per annum ; secondly, that using gas without limitation, affording a higher degree of illumination, the expense would be $5,809 72, or nearly 40 per cent. less than the actual cost of electrical illumination last year.

In the above estimate of cost of electricity—based on the transfer of zinc in the voltameters—it is assumed that the charge of the owners of the electric plant covers all the items of electricians' wages, interest, depreciation and profit on operation of plant, renewal of lamps, oil and waste for engines, and all other items of expense not otherwise specifically mentioned above. Should this not be the case, and other items of expense, of which I am unaware, are borne by the Depot Company, then the cost and disparagement of the electric light becomes greater than I have shown it to be.

Apart from the cost of the light produced by the electric plant, there are other points which have been pointed out in my general report, and to which I take the liberty of referring in this summary.

During the weighing of the zinc plates of the voltameters used by the Electric Light Company to measure the amount of light furnished to the Depot Company, the phenomenon, which I am informed is not unfrequent, was developed of the diminishing plate gaining instead of losing (as it should if the meter is working properly) in weight ; showing an apparent reversal of current for certain meters, the custom in cases of this kind being (as I am informed) to take the gain in weight of the plates—which should have lost in weight—as the measure of zinc transferred. Although authorities on electrical science assert that, with a given strength of current, the rate of transfer of zinc from one plate to another in a voltameter is constant for any given time, and knowing the time and current the loss of zinc by the positive plate may be calculated from constants determined by experiment, it seems strange that the current should be reversed, as it was in the meters noted above. And this fact, of which we have ocular evidence, would indicate a state of affairs very dangerous to the pocket of the consumer of light ; for if these meters will work backwards (as it were), why should they not work forwards at a rate greater than that assigned by theory, and cause a registration of more light than is actually furnished ? If I were a consumer of electric light, I should require better

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evidence than that before me now to induce me to accept the records of these meters as a reliable statement of the light furnished.

Another fact to which I will again refer is the great range in candle-power of the lights, with a slight change in the intensity or pressure of the electric current. Thus the (D) 32 nominal candle-power lamp with the filament placed at an angle of 45deg. to the plane of the photometer bar, with a resistance producing 99 volts, the current was 1·05 ampere, and the candle-power 23·94; while with a resistance producing 99 volts, the current was 1 268 ampere, and the candle-power 42·89, or nearly twice as great as in the previous test. The reduction of the resistance and current diminishes the load on the dynamos and engines, prolongs the life of the lamp, and materially diminishes the illuminating effect. Should it appear that at any time during the day or night the voltage (pressure) of the electric current is reduced below 99 volts—which I have reason, from our running record, to believe is the case—then the illumination produced will be greatly diminished from the standard, while the cost of the light to the consumer may be practically unchanged.

From a comparison of currents required to maintain the test lamps, it appears that the cost is about the same for a weak as for a strong light, or while the illuminating effect or candle-power of the light steadily diminishes with age (use), the current to maintain its incandescency remains substantially constant.

As a matter of fact, it may be shown that the current, and consequently the cost to the consumer, becomes greater with a lower candle-power. Thus:—

32 Candle-Power Lamps.

Actual candle-power.	Ampere.
62·44	1·29
30·16	1·31

Or, with a loss of illuminating effect of 52 per cent., the cost of the light is increased nearly 5 per cent.; whence the relative cost of the weaker light is 217 per cent. of the stronger light.

16 Candle-Power Lamps.

Actual candle-power.	Ampere.
36·33	0 773
21·10	0 816

Or, with a loss in illuminating effect of 42 per cent., the cost of the light is increased upwards of 5½ per cent.; whence the relative cost of the weaker light is 182 per cent. of the stronger light. Or, while the electrical energy was 1·25 × 99 = 123·75 watts for the 62·44 candle-power light, it was 1·31 × 99 = 129·69 watts for the 30·10 candle-power light; and while the electrical energy was 0·773 × 99 = 76·527 watts for the 36·33 candle-power light, it was 0·816 × 99 = 80·784 watts for the 21·10 candle-power light. The power of the driving engines and the dynamos is usually stated in watts, being the product of the horse power of the engines into the constant 746, or the product of the electric current (ampere) into its pressure or intensity (volts). Hence the more watts required to maintain a lamp, the greater the cost of the light.

With gas or kerosene a given consumption of illuminating substance furnishes a constant power of light; while a diminished brilliancy of light is always accompanied by a reduction in the consumption of illuminating material and a corresponding reduction of cost. With the Edison light, however, it seems that a reduced brilliancy of lamp is not accompanied by a reduction of expense; but under certain conditions of lamps and service the cost may be actually greater for a light of 16-candle power than for one of twice this brilliancy. Changing the position of the filament (or loop) of the lamp, under the same conditions of current and pressure, produces a reduction of 50 per cent. in the illuminating power.

The most startling result of this test to me is the loss of over 60 per cent. in effect between the driving engines and the lamps; or of every foot-pound of work or watt developed by the engines, less than 40 per cent. is actually realised in the illuminating power of the lamps. In any other application of steam power to useful work, the relation of the work done to the power expended in doing it must come within 80 or 90 per cent. of the latter to satisfy demands for economy.

The tests of the lamps for brilliancy were made by Prof. French, of the Cincinnati University; and the tests for the current required to maintain the lamps were made by Mr. C. E. Jones, electrician, of this city, whose reports were submitted with my general report.

REGULATIONS OF THE BOSTON FIRE UNDERWRITERS' UNION.

The following regulations for the wiring of buildings have recently been drawn up by the Boston fire offices:—

Arc Light Wires.

Conducting wires must be seven feet above roofs, and placed so as to avoid ladders of the fire department and fire shutters. Whenever electric light wires are in proximity to other wires, dead guard wires must be placed so as to prevent any possibility of contact with foreign wires, in case of accident to the wires or their supports. Conducting wires must be secured to insulating fastenings, and covered with an insulation which is waterproof on the outside and not easily worn by abrasion. Whenever wires pass through walls, roofs, floors or partitions, or there is liability to moisture, abrasion, or exposure to rats and mice, the insulation must be protected with rubber, stoneware or some other satisfactory material. Wires entering buildings must be wrapped with tape, and bent in such a manner that it will prevent the water entering the building. All wires passing over or under steam, gas, or water pipes, must have a good insulation between them and the pipes. Blocks of wood are the most desirable. This rule also applies to foreign wires—they should be treated the same as pipes. Wires should go over water pipes where it is possible, so that the moisture will not settle on the wires. Hard rubber hooks are not desirable as fastenings, and tacks or staples must in no case be used for fastenings, or brought in contact with the wire. In damp places, wires must be run on glass insulators, and kept entirely clear from contact with inflammable material, and any substance likely to make a ground connection.

The use of lead-covered wires, or wires whose covering contains paraffin, is prohibited. The use of underwriters' wire will not be passed where it is concealed in any manner. It must be in plain sight—on the walls or ceilings. Wire that is covered with moulding must have a water-proof insulation that is approved by this union. Joints in wires to be securely made and wrapped with tape; soldered joints are desirable, but not essential. Wires conducting electricity for arc lights must not approach each other nearer than one foot. Care must be taken that the wires are not placed above each other in such a manner that water could make a cross connection. Cut-off boxes for arc lights must have the words *On* and *Off* marked on them. They must be placed in a well-protected and accessible place, so that they can be operated by the firemen or police.

Arc Lamps.

For arc lamps, the frames and other exposed parts of the lamps must be insulated from the circuit. Each lamp must be provided with a separate hand-switch, and also with an automatic switch, which will close the circuit and put the lamp out whenever the carbons do not approach each other, or the resistance of the lamp becomes excessive from any cause. The lamps must be provided with some arrangement or device to prevent the lower carbons from falling out, in case the clamp should not hold them securely.

For inside use, the light must be surrounded by a globe, which must rest in a tight stand, so that no particles of melted copper or heated carbon can escape, and when near combustible material, this globe must be protected by a wire netting. Broken or cracked globes must be replaced immediately. Unless a very high globe is used, which closes in as far as possible at the top, it must be covered by some protector, reaching to a safe distance above the light.

Incandescent Wires.

Conducting wires must be seven feet above roofs, and placed so as to avoid ladders of the fire department and fire shutters. All connections must be soldered and wrapped with tape. Whenever the electric light wires are in proximity to other wires, dead guard wires must be placed so as to prevent any possibility of contact with foreign wires, in case of accident to the wires or their supports. Conducting wires must be secured to insulating fastenings, and covered with an insulation which is waterproof on the outside and not easily worn by abrasion. Whenever wires pass through walls, roofs, floors or partitions, or there is liability to moisture, abrasion, or exposure to rats and mice, the insulation must be protected with rubber, stoneware or some other satisfactory material. Wires entering buildings must be wrapped with tape, and bent in such a manner that it will prevent the water entering the building. All wires passing over or under steam, gas or water pipes, must have a good insulation between them. Blocks of wood are the most desirable. This rule also applies to foreign wires—they should be treated the same as pipes. Soft rubber tube is not desirable as an insulator. Wires should go over water pipes where it is possible, so that the moisture will not settle on the wires. Where incandescent wires enter buildings, they must have double-poled safety catches as near the entrance as possible. The main wires must not be less than two and a-half inches apart, except where they are in grooves. The use of lead-covered, or wires whose covering contains paraffin, is prohibited. All wires that are fished over the ceiling, or in the walls, must have a waterproof insulation satisfactory to this union. This rule also applies to wires covered with moulding, or concealed in any manner. Where underwriters' wire is used, it must be in plain sight on the walls or ceilings. Care must be taken that the wires are not placed above each other in such a manner that water could make a cross connection. Wires that are run in damp places must be run on glass or porcelain insulators of suitable form.

For incandescent lamps the conducting wires leading to each building and to each important branch circuit must be provided with an automatic switch or cut-off, or its equivalent, capable of protecting the system from any injury due to an excessive current of electricity. These devices must be proportioned to protect the smallest wire in the loop to which they are attached. On all loops of incandescent circuits safety catches must be used on both sides of the loop, and switches on such loops should be double poled. Ceiling blocks that are used on pendant drops must have safety metals in them where flexible cord is used. Cord should have a knot tied in it with the knot on the top side of the block, so that the strain will come on the knot instead of on the connection; and where it is possible a knot should be inside of the socket, the same as the block. The small wires leading to each lamp from the main wires must be very thoroughly insulated, and if separated or broken, no attempt made to join them while the current is in the main wires. When wires are put on gas fixtures, the fixture must be isolated from the main pipe, and the insulator used for this purpose must be made so that the sediment in the gas will not form a connection over the insulating material. Chandeliers or brackets attached to any ground connection must have insulating yokes or couplings on them. Individual insulating

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of lamps at the sockets will not be passed except on brackets in special cases that may be approved by the inspector.

DYNAMO MACHINES.

Dynamo machines must be located in dry places, not exposed to flyings or easily combustible material, and insulated upon wooden foundations. They must be provided with devices capable of controlling any changes in the quantity of the current; and if these governors are not automatic, a competent person must be in attendance near the machine whenever it is in operation. Each machine must be used with complete wire circuit; and connections of wires with pipes, or the use of ground circuits in any other method, are absolutely prohibited. The whole system must be kept insulated, and tested *every day* with a magnet for ground connections in ample time, before lighting, to remedy faults of insulation, if they are discovered; and proper testing apparatus must in each case be provided. This applies to both central station and isolated plants. Testing circuits for ground with a battery and bell is not considered a reliable test. Preference is given for switches constructed with a lapping connection, so that no electric arc can be formed at the switch when it is changed; otherwise the stands of switches, where powerful currents are used, must be made of some incombustible substance which will withstand the heat of the arc when the switch is changed.

MOTORS.

Wires for motors should be run exactly as for lamps on similar circuits. On low-tension circuits where motors are run in multiple safety catches must be used on each side of the circuit. On high tension circuits the same restrictions apply as for arc lamps, and suitable cut-outs must be provided. Motors must be treated as dynamos as regards insulation, flyings, dampness, &c. While these rules are intended to be complete, some cases may arise where, in the judgment of the inspector, some deviation from them may be necessary in order to secure safety.

RULES FOR RUNNING INCANDESCENT CIRCUITS FROM ALTERNATING MACHINES.

Outside wires should be treated as arc light wires, inside wires the same as incandescent circuits. Converters on alternating circuits must be outside of buildings, and must be placed high enough from the roof to prevent possible injury to firemen.

RULES TO APPLY TO THE RUNNING OF INCANDESCENT CIRCUITS WORKED FROM ARC CIRCUITS.

The running of incandescent lights or systems on arc circuits should be avoided; but wherever this is unavoidable a proper device or "distributor," such as may be approved by this union, must be provided to prevent the possibility of an excessive arc current being thrown on to any one portion of the incandescent system; such device or "distributor" *must* have the approval of this union before it is put into operation. It must remain open to inspection at all times, and no change made in any part of the installation after it has been approved without consent of this union. Only such wire as has been approved by this union shall be used in constructing lines and circuits.

Wires must be run in plain sight. In damp places they must have a waterproof covering. The positive wire or wires must be kept at least two and a-half inches from the negative wire or wires in running from the distributor or regulator to the fixtures and lamps and return; except that "twin wire" may be used for a single lamp. No wires should be run through partitions, floors or walls, without being encased in a tube of hard rubber, porcelain, or covered with tape. Soft rubber tube is not desirable as an insulator. The "safety fuses" must be so proportioned that they will melt long before the wire is heated to an unsafe degree. Dust must not allowed in the distributor-box or any of the electrical connections. The contact points should be kept clean, and care should be taken to insure solid electrical connections at all the points of contact, and all parts must be kept free to move easily. In case any defect should arise in the distributor or regulator, or the wiring thereto, it must be arranged so as to automatically and absolutely shunt off from the arc circuit at once. In working distributors, the line or circuit current must be kept at its standard amount by tests made by ampere-meter from time to time. In no case must the amount exceed the standard. Every company shall have a competent and reliable person to examine, daily, every distributor and regulator, or similar device which may in the future be applied to arc circuits.

Where incandescent lights are run on arc circuits, the following-named practices are *strictly prohibited:* Fastening or attaching electroliers or lamps to any gas fixture which may be in electrical connection with the earth. The running of *concealed* wires to the electroliers or lamps *under any circumstances*. They must be entirely open to view. The placing of any distributor box or regulator, electrolier, bracket, or lamp in such position that it may be connected in any way with any other wires, steam fittings, gas pipes, gas fixtures, &c., which may be electrically connected with the earth. The placing of the distributor, electrolier, &c., in any damp location, or in close proximity to any metal or other conductor of electricity. The building or placing of anything around the distributor or regulator so as to cut off easy access to it, or obstruct the access of air to it.

All joints after leaving the distributor or regulator must be soldered, using acid as flux. Resin will not be approved under any circumstances. All new devices should be submitted to the inspector of the union, and must be approved by him before permission can be given for their use.

While these rules are intended to be complete, some cases may arise where, in the judgment of the inspector, some deviation from them may be necessary in order to secure safety.

CORRESPONDENCE.

THE LIGHTING OF THE AMERICAN EXHIBITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We observe that Messrs. Hornsby wrote you last week in respect to a paragraph which appeared several weeks ago in your valued paper.

Your editorial footnote clears us of having in any way inspired the paragraph objected to, and we will at once proceed to criticise the technical points raised.

In the first place we cordially endorse the remarks of Messrs. Hornsby as to the very unfavourable conditions generally. We certainly had, both of us, great difficulties to contend with, and these were entirely beyond either their control or ours; but they need not seek to excuse themselves by disparaging us. In defending ourselves, it is only necessary to state that in our contract with the exhibition authorities we had to pay a fine of 1d. per lamp per minute for any lamp out through our fault; and not a single penny has been claimed.

One more point we would like to mention. Messrs. Hornsby's indicator tests show that the I.H.P. was 348, but the number of lamps is not correctly given by them.

The total number of 2,000 candle-power lamps was 287 and not 242, and this is evidently a very fair result considering that two 50-light dynamos were running empty the whole time, and that the shafting absorbed considerable power, owing to the unstable foundations referred to by Messrs. Hornsby.

This appears to us a good record.—Yours, &c.,

LAING, WHARTON AND DOWN.

82, New Bond-street, W., December 29th, 1887.

PRIMARY BATTERIES FOR HOUSE LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Thompson is not quite convinced that the statement in Mr. Nursey's paper that "sixteen cells will maintain ten 10 candle-power Swan lamps for about twenty hours" is to be taken literally, and prefers to abide by the supposition that the work thus done represents five rather than eight electrical horse-power hours; but he frankly concedes that even with his own figures "it will be evident on referring to the table" [published in your issue of December 9th] that "when using small engines and dynamos the cost of fuel only ranges from 7 to 15 per cent. of that apportioned to labour."

That, after all, was the main, if not the only, issue discussed in a correspondence which commenced by my taking exception to Mr. Desmond FitzGerald's exaggerated attack on primary batteries for illuminating purposes, founded on his theory that they must be compared with dynamos, by means of which, "at a cost considerably under one halfpenny" [½d. is the cost of 5lb. of coal at 18s. 8d. per ton], "we can by the agency of the steam engine obtain an electrical horse-power hour."

We are now both agreed that no such crude comparison between the cost of coal and zinc has any practical application to primary batteries for house-lighting purposes.—Yours, &c.,

O. C. D. ROSS.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions*

17,592. R. B. LEE. Manchester. Improvements in laying wires for the transmission of electricity. December 22.

17,599. R. E. B. CROMPTON and J. SWINBURNE. Chelmsford. Improvements in dynamo electric machines. December 22.

17,631. J. C. LEMMENS. London. Improvements in electric batteries. December 22.

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17,655. R. H. D. MILLS. London. Improvements in electric incandescent lamps. December 23.

17,682. T. CHEESMAN. Hull. Switching apparatus and vibrating appliances for mechanical telephones. December 23.

17,722. J. SACHEVERELL GISBORNE. London. Improvements in electric telegraphic apparatus for transmitting and receiving signals on board ship or other places. December 24.

17,726. J. G. STATTER. London. Improvements in or connected with electro motors. December 24.

17,757. M. MCMULLIN. London. Improvements in or relating to the application of portable electric batteries and incandescent lighting to articles of wearing apparel and other analogous purposes. December 24.

17,762. L. SELLNER. London. Improvements in electric signalling apparatus. December 24.

17,807. F. L. RAWSON. Rheostats or similar electrical instruments. December 27.

17,812. C. ZIPERNOWSKY. Machines for the production of alternating electrical current. December 27.

17,837. P. M. JUSTICE. Generating electricity from heat. December 28.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

December 24, 1887.

12,032. A. FEATHERSTONHAUGH. London. Improvements in electric incandescent lamps. September 22, 1886.

16,650. O. SKRIVAN and F. DVORAK. London. Improvements in electric apparatus for the control of watchmen. December 18, 1886.

16,879. W. S. STELJES. London. Improvements in the transmitting and receiving apparatus of printing telegraphs. December 23, 1886.

16,120. E. TYER. London. An improvement in voltaic batteries. November 23, 1887.

December 28, 1887.

17,120. R. E. B. CROMPTON and J. SWINBURNE. Chelmsford. Improvements in dynamo electric machinery. December 31, 1886.

3,998. F. J. CHARY. London. An improved apparatus for the application of electric light for photographic purposes. March 16, 1887.

PATENTS SEALED.

December 20, 1887.

10,056. W. WALKER. London. Improved contact apparatus for use in automatic electric signalling on railways. July 18, 1887.

12,189. H. H. LAKE. London. A method of and apparatus for the electrical transmission of sound (E. E. Graves, United States). September 8, 1887.

December 27, 1887.

15,524. F. C. ALLSOP. Bexley. Improvements in electrical tramways and railways. November 27, 1886.

16,616. C. LANGDON-DAVIES. London. Apparatus for the employment of vibratory electricity in telegraphy. December 17, 1886.

1,693. C. D. ABEL. London. Improvements in disc dynamo or magneto electric machines (La Compagnie Continentale Edison, France). February 2, 1887.

11,674. M. BAILEY and J. WARNER. London. An improved method of suspending and protecting from injury or breakage incandescent lamps when used for mining or other purposes. August 27, 1887.

12,406. A. J. BOULT. London. Improvements in or relating to electrical type-writers (J. F. McLaughlin, United States). September 13, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

15,719, 1886.—J. ROOTS. Administering electric currents. (Price 8d.)

1,390, 1887.—R. C. JACKSON. Dynamo-electric machines, &c. (Price 4d.)

1,499, 1887.—T. O. CALLENDER. Laying and insulating underground wires. (Price 6d.)

1,609, 1887.—W. J. BARNSDALE.—Electrically wound clocks. (Price 8d.)

1,667, 1887.—M. MCMULLIN. Applying electricity for illuminating, &c., purposes in theatrical representations, &c. (Price 8d.)

6,584, 1887.—R. B. MADDISON. Electric marine governor. (Price 8d.)

13,778, 1887.—W. WALKER. Automatic electric signalling for railways, &c. (Price 8d.)

14,893, 1887.—L. G. WOOLLEY. Generating electricity. (Price 6d.)

14,901, 1887.—C. R. GOODWIN. Electric batteries. (Price 6d.)

THE EASTERN TELEGRAPH COMPANIES' ANNUAL EAST END CONCERT.

On Saturday, 17th inst., the annual concert in aid of a fund to provide Christmas dinners for the poor of the East End of London in their own homes was given in the Great Assembly Hall, Mile End-road, Sir James Anderson in the chair.

These concerts have been given for the last seven years by gentlemen in connection with the Eastern Telegraph Companies, assisted by friends in sympathy with the object, who very kindly help considerably to cheer many an East End home by their readiness to take part in the concert and to contribute to the fund.

Sir JAMES ANDERSON commenced the proceedings by saying :—Another year has come and gone since we last met in this beautiful hall, with the same object which now brings us together, which is to extend some practical sympathy at this Christmas season to our less fortunate neighbours (cheers). All through the past history of the world there has always been, there is now, and I believe always must be, in every community a vast number of poor and unsuccessful people. All of us, excepting the very young, perhaps, know many even amongst our own friends who never seem to get their heads above water, even though they appear to struggle as bravely as those who are successful. In the language of the poet Longfellow, they seem

> "Born down by their losses,
> Weary with dragging their crosses,
> Too heavy for mortals to bear."

And no nation has ever yet solved the problem of dealing successfully with poverty and distress. There have been nations which fed the poor and the idle, with the result that the idle became the masters, and the nations perished, conquered by other nations in which every man was a trader or a fighter (hear, hear). Think it out as you will, and look back through all the ages, and you will find no record of any good thing ever done without hard work (cheers). The greatest man who has ever put warning or advice on record since the first Christmas Day dawned upon earth says : "If any man will not work neither shall he eat." No one has ever yet told us how to get through life without struggling. The battle of life is an expression as common as it is true. Do what we can, but do something, is the only advice we can take to ourselves or give to others, no matter to what class we or they belong. The Chelsea sage, the late Thomas Carlyle, put upon record something like a bitter cry : "Produce, produce, be it but the infinitesimal fraction of a product, in God's name produce it!" (cheers). You will naturally say that is all very well so far, but what is to be done with those who cannot get work, the thousands who from sickness or other causes cannot work? The answer may not be satisfactory, but I do not know of any other ; all we have to expect is the help and sympathy of relatives, friends, and fellow citizens. Fortunately in this country there is a growing band of workers seeking in many ways to find out the weary and heavy laden and carry relief and sympathy amongst them I believe there is hardly a sorrow or trial so great that cannot in some degree be soothed by sympathy (applause). When I used to voyage to what we called heathen lands I used to think that had it been my lot to be a missionary I should have learned in the native dialect to have told them the parable of the Good Samaritan. I fancied I could have rung changes in many an exhortation upon all its beautiful points. I think there is no possible equal to it to illustrate the object of our Christian religion, or of anything worth calling a religion (cheers). The Good Samaritan did not use many words, but carried the wounded man to an inn, soothed his wounds, and left means to sustain him until he recovered. I should not wonder if out of this parable there has come the common English saying, "How much do you sympathise?" There are very few in any nation rich enough to give to every charitable object. With the vast majority of even what are known as successful people, few can do more outside the demands of their own families and relations than give here a little and there a little. We are not met here to-night to plead for any heroic object. We are only met to sympathise to the extent of giving some good cheer to as many families in their own homes on Christmas Day as the sum collected will pay for. To that extent our friends who have kindly volunteered to entertain us to-night, and you who have paid to be entertained, are the good Samaritans of this occasion, and all of us have the satisfaction of knowing that we are doing something in the way of practical sympathy that cannot fail to be accepted thankfully by the families who are selected to be the recipients of the good things to be provided (loud cheers).

The speech was listened to with manifest interest and was heartily applauded.

The concert was then proceeded with and proved to be the best yet given. Mr. W. J. Finnis sang in first rate style "One night came on a hurricane," and "Oh! oh! hear the wild wind blow," the latter specially receiving hearty applause. Mr. W. H. Owen (who is a great favourite at the Assembly Hall) recited in two parts, Dickens's "Cheap Jack," with remarkable elocutionary effect. Miss Maude Snell, who upon her appearance was very warmly greeted, sang "The City of Rest" and "When

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the heart is young." Miss Snell is the fortunate possessor of an exceptionally good soprano voice which she uses to the best possible advantage. Mr. Sadleur Brown sang "Tell me, Mary," and "O'er the Hills of Normandie," in faultless style, his voice being a remarkably pure one. Miss Louise Courtney rendered "Jerusalem" and "The Minstrel Boy," and Miss Ida Everard "Sing, Sweet Bird," and "The Wishing Well." Both of these ladies were heartily applauded for their songs, and they richly deserved it all, for their singing was really excellent. Mr. Guildford Dudley recited "A September Gale," and "The Jackdaw of Rheims," both of which created roars of laughter and thunderous applause. A violin solo was given by Mr. Hughes Brabant, entitled "Scène de Ballet," which was very greatly appreciated. The splendid organ was perfectly manipulated by Mr. Arthur Briscoe, who deserves the very highest commendation for his organ solo "Marche Militaire," and for the first class talent displayed as accompanist. It may here be said that a song, "Bells o' Dee," composed by this very promising musician, was sung during the evening, and was well received. Mr. J. H. D. Denham brought the programme to a close with the "Bedouin Love Song," which he sang very effectively.

In proposing a vote of thanks to Sir James Anderson for presiding, Mr. E. H. Kerwin expressed the great pleasure they had in seeing Sir James again amongst them, and thanked him for his kindness in presiding and his generosity in subscribing to the dinner fund. Mr. James Haysman (who had purchased one hundred tickets for distribution among the poor of the neighbourhood) seconded the vote of thanks, remarking that it was not the first time he had heard of Sir James's philanthropy. The vote was then put to the meeting, and was carried with acclamation.

The proceeds of the concert and the donations amounted to over £75, and on Friday last 275 deserving families received goods for a very substantial Christmas dinner, consisting of beef, suet, flour, bread, plums, currants, sugar, and some tea. The total number of persons thus fed was about 1,200.

COMPANIES' MEETINGS.

The National Company for the Distribution of Electricity by Secondary Generators (Limited).

The fourth ordinary general meeting of the shareholders in this Company was held at the offices, Warwick-street, Regent-street, on Wednesday, Mr. Wm. D'Oyly in the chair, when the report of the Directors and statement of accounts were adopted. The following is the report of the Directors of the Company:—

Shortly after the report presented to the shareholders on the 18th March, 1886, the work of the Company was seriously interrupted by infringers of the Company's patents. Acting under the advice of the most eminent counsel and the highest scientific authorities, the Directors have instituted proceedings in the English and Foreign Courts to protect the interests of the shareholders. The installation at Tours, in France, which has been working satisfactorily without interruption since January, 1886, was the object of attack by infringers, whose patent was ultimately declared invalid, the Court of Tours giving damages to the Banque d'Escompte de Paris, which held an exclusive licence to employ the company's system in France. The Directors have claimed damages from the Banque d'Escompte, whose contract with the Company your Directors have cancelled. In the month of May, 1886, the Directors were compelled to bring an action against Sir Coutts Lindsay and Co. (Limited). This action was settled upon the payment by Sir Coutts Lindsay and Co. (Limited), of the royalties claimed and costs. Near the close of 1886, Mr. Ferranti, who had been engaged as engineer by Sir Coutts Lindsay and Co. (Limited), filed a petition to revoke the Gaulard-Gibbs patent of 1882 on the ground that it interfered with his patent of 1885, alleging informalities in the specification and anticipation. Subsequently it became necessary to bring another action for infringement against Sir Coutts Lindsay and Co. (Limited) and Mr. Ferranti. These two actions have yet to be tried, and will probably be merged in one. The Directors have felt it their duty to attack two infringing patents in Germany, and have done so with success. Both in regard to the protection of the Company's patent rights in Germany and the development of the business there, the Directors have secured the co-operation of Messrs. Siemens and Halske, of Berlin. The installation at Aschersleben is working satisfactorily and has been extended. Although litigation is exceedingly costly, it is inevitable where valuable patents are concerned; but the sacrifice involved both in cash outlay and interruption to profitable work is likely to be largely compensated by future advantage. Mr. George Westinghouse, jun., who acquired the exclusive right to use the Company's patents in the United States of America, has upheld them in the United States Courts. Mr. Westinghouse is actively pushing the business; his Company in a recent letter stated—"We are quite confident that by the 1st of January, 1888, we will have more than 120,000 lamps in use with secondary generators." These 120,000 lamps are divided amongst about eighty central stations, most of them capable of extension. This is the result of little more than one year's work, producing in royalties to the Company upwards of £4,000, which must be considered most satisfactory. The Directors are glad to be able to state that in this country the trade generally have shown a desire to recognise the Company's foundation patents. Messrs. Hammond and Co. are employing the Gaulard-Gibbs system at Eastbourne and Brighton under licence from this Company; other negotiations are in progress for the extensive use of the Company's system in this country. The Directors have been enabled to close the small works in Castle-street since entering into a manufacturing contract with Messrs. Elwell-Parker (Limited), of Wolverhampton. This contract has already proved useful; it formed only part of an arrangement with the late Mr. Charles Moseley, of Manchester, which would have been of great importance to the Company, but which could not be fully carried out, in consequence of the untimely death of Mr. Moseley. The Directors are pleased to be able to state that Sir Geo. Elliot, Bart., M.P., who has taken great interest in the Gaulard-Gibbs system for some years past, is likely to join the Board of the Company. The town of Tivoli has been lighted by the Company's system since August in last year, the power used being that of the waterfalls. A contract has been entered into for transporting 2,000 horse-power from the Tivoli Falls to Rome. At the Paris Exhibition of 1886 a "Diplôme d'Honneur" (the highest honour) was awarded to the company's exhibit, which was superintended by Mr. Gaulard in person. The Directors confidently anticipate a great future for the Company, by judiciously meeting the loyal desire generally manifested to recognise the Company's foundation patents. To secure this end they propose to ask moderate royalties, and to supply the most efficient apparatus at prices that remove even the temptation to infringe. The Directors retiring by rotation are Mr. Lucien Gaulard and Mr. J. Dixon Gibbs, who offer themselves for re-election. The auditor, Mr. J. H. Thornton retires, and is eligible for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 23rd inst. amounted to £4,993.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 23rd December, after deducting the "fifth" of the gross receipts payable to the London-Platino Telegraph Company, were £4,006.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The directors of this company have declared a dividend of 6s. per share for the half-year ending 31st December, 1887, payable 7th January, 1888.

PERSONAL.—Mr. C. E. Wetton, who has been for some years with Messrs. Paterson and Cooper, will, from 1st January next, represent the Telegraph Manufacturing Company (Limited), of Helsby, near Warrington.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Dec. 28.		Business Done Week Ending Dec. 28. Highest.	Lowest.
Anglo-American	37,	38	37½	—
Do. Preferred	61,	62	62	61
Do. Deferred	13,	14	—	—
Brazilian Submarine	11⅞,	12⅛	12⅛	12 1-16
Cuba	11¾,	12¼	12¼	—
Do. Preference	18,	19	—	—
Direct Spanish	3½,	4	—	—
Do. Preference	8,	9	—	—
Direct United States Cable	8⅜,	8⅝	—	—
Eastern Telegraph	11⅛,	11⅜	11⅝	11 3-1
Do. 6 per Cent. Preference	14¼,	14¾	—	—
Do. 5 per Cent. Debentures, 1899	106,	109	—	—
Eastern Extension	12⅛,	12⅜	12⅜	12 3-16
German Union	9¼,	9¾	—	—
Globe Telegraph and Trust	5⅜,	5⅝	5½	5 7-16
Do. Preference	13⅛,	13⅜	13¼	—
Great Northern	13½,	14	14	—
Indo-European	87,	89	—	—
London Platino Brazilian	4,	4½	—	—
Reuter's	8,	8½	8½	8½
Submarine	125,	135	—	—
West Coast of America	4¾	5¼	5	—
Do. Debentures	110	114	—	—
West India and Panama	¾,	1	13-16	¾
Do. 1st Preference	9½,	10	9⅞	9⅞
Western Brazilian	8¾,	9	8 15-16	8⅞
Western Union 7 per Cent. 1st Mortgage	120,	125	—	—
Do. 6 per Cent. Sterling Bonds	101,	104	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	9-16,	11-16	—	—
Oriental	¼,	⅜	—	—
United Telephone	11½,	12	—	—
United River Plate Telephone	4¾,	5¼	—	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	2,	2½	2⅜	—
Do. (fully paid)	2¾,	3¼	3	—
Swan	1⅛,	1⅜	1⅜	—
Maxim Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	88,	89	38½	[illegible]
India Rubber, Gutta Percha and Telegraph Works	20½,	21½	21½	20⅞

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 503.—Vol. XX. FRIDAY, JANUARY 6, 1888. Price 4d.

NOTES.

We are glad to learn that Sir James Anderson will be the Chairman of a Committee of Telegraph Directors and friends who intend shortly to give a Banquet to Sir John Pender, in recognition of his valuable services to Telegraphy, and to congratulate him on the distinction of K.C.M.G. which Her Majesty has been pleased to confer upon him. Mr. William Payton, of Winchester House, 50, Old Broad-street (to whom communications may be addressed), will act as Secretary to the Committee, and Mr. George Draper, of the same address, as Treasurer.

It is quite unnecessary to recapitulate the numerous claims which Sir John Pender has to the gratitude and esteem of all who are connected with Submarine Cable Telegraphy. After the failure of the first Atlantic cable Sir John Pender was one of the foremost amongst the few who still retained their faith in the ultimate success of the gigantic enterprise, and to his personal influence and his liberal financial support the subsequent and successful attempts were mainly due. To his untiring energy and remarkable foresight we also largely owe the success of the Mediterranean, the Eastern, Australasian, and African systems of Cable Telegraphy. In fact the commercial development of the world-wide system which centres in this metropolis—so far as it is due to any one individual—is emphatically due to Sir John Pender. We are therefore justified in believing that the well-merited distinction which he has received will be welcomed with unqualified satisfaction and pleasure throughout the telegraph world.

Mr. Magnus Volk's electric dog-cart, which we describe elsewhere, will prove, we trust, the precursor of a large and miscellaneous family of electric vehicles. This is not, of course, by any means the first attempt which has been made to employ electric locomotion on ordinary roads. To mention only one of the earliest and most successful experiments, it will be remembered that in 1883 Profs. Ayrton and Perry exhibited an electrically-propelled tricycle. Probably, however, Mr. Volk has been well advised to turn his attention at first to a heavier class of vehicle. Although the most advantageous distribution of the dead weight between the vehicle and the cells may, no doubt, be ascertained approximately by calculation, one of the most important points to be considered will naturally be the storage capacity attainable within moderate limits of weight. Now, with a vehicle of the dog-cart type, it would be easy to increase the number of cells when the full load of passengers is not carried, so that with a single rider three or four times as many cells might be employed, and the length of the run proportionately increased.

Mr. Volk's experiment shows conclusively that upon asphalte the coefficient of traction may be taken at less than one half its value upon an ordinary macadamised road. In the next edition of the "Coming Race," or the "Fiftieth Century," we shall probably have a vision of a country where all the roads are paved with asphalte, and everyone travels on his own electric carriage at 40 miles an hour.

Mr. Irish's india-rubber conduit for electric tramways, which we describe elsewhere, seems to offer a promising solution of the difficult problem of electric traction in towns minus storage batteries. The most serious objection to the proposal will probably lie in the expense, for the tubes must necessarily be very thick to ensure the elasticity on which the whole system relies. With india-rubber at 3s. 2d. per pound, and not likely to fall in value, this difficulty will prove, we fear, a serious one. It is nevertheless impossible to overlook the beauty and ingenuity of Mr. Irish's device.

If there is any rubber left after Mr. Irish's wants are fully supplied, Mr. Bozon proposes to employ it to give increased elasticity to overhead wires. We have examined Mr. Bozon's "compressors" with interest, and while it is open to many of the objections which have recently been urged against Mr. Caws's "springs on telegraph wires," we must admit that in some obvious points, as in cost and weight, the india-rubber arrangement is superior to the steel spring. Mr. W. H. Preece has, however, already stated in these columns that, so far as the Post Office is concerned, the necessity for such a device does not exist, and to this it may be added that had such a requirement been manifest, it would doubtless long ago have been designed and employed by the Government telegraph engineers.

On the other hand, in the case of the over-house lines of Telephone Companies, perhaps more especially where these are of copper (for which, according to Mr. Caws, such a device is pre-eminently adapted), and also for overhead electric light

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circuits, it is at least open to discussion whether something of the kind might not prove advantageous.

THE French Academy is, perhaps, a little unfortunate in its choice of a subject for competition in electrical science. The offer of a gold medal of the value of 3,000fr. has been renewed for several years in succession, so far without result. The subject selected is "The Perfection in some important point of the Theory of the Application of Electricity to the Transmission of Power." Last year one paper only was sent in, but this did not appear to the committee to be of sufficient merit to receive the award. If we may be permitted to offer our own opinion, we would remark that as regards the transmission of power by continuous currents, the theory is already complete in every practical sense of the term, and has been so ever since the laws of efficiency and maximum output were properly understood. On the other hand, the conditions affecting the transmission of power by alternating currents have only quite lately been set forth in detail. The current number of the *Philosophical Magazine* contains a most important contribution to the subject by Mr. T. H. Blakesley, M.A., in a paper entitled "On a Geometrical Determination of the Conditions of Maximum Efficiency in the case of the Transmission of Power by Means of Alternating Electric Currents." This is a further extension of the geometrical treatment of alternating currents first developed by Mr. Blakesley in the columns of this journal in 1885. An equally important paper on the other side of the same question was contributed to the British Association meeting in the present year by Mr. G. Kapp, "On the Condition of Maximum Work Obtainable from a given Source of Alternating Currents." These two papers, therefore, cover between them the whole ground of maximum efficiency and maximum output, and had they been submitted to the Academy it may be taken for granted that either or both would have received the award. It would thus appear that there is very little likelihood, in the present condition of our general knowledge of the subject, that any further development of the theory of the electrical transmission of power will be immediately forthcoming, and it is perhaps unfortunate that the Academy has not propounded for this year some more promising subject.

ALTHOUGH the Grand Theatre at Islington was chiefly lighted by electricity, the cause of the disaster which levelled it to the ground in the early morning of yesterday week was the gas jets in the flies—that is to say, in the most inflammable portion of the structure. The electric current, it is safe to assume, was turned off at the end of the performance, but one or more gas jets were kept burning for purposes of night inspection. Of all places in a theatre this is the one where gas should not be allowed on any pretence whatever, and to keep it burning in such a situation is to court the very consequences the inspection is intended to guard against.

WRITING to *The Times* on this subject, Mr. W. T. MAKINS, who, it may be remembered, witnessed the outbreak of the fire at the Opera Comique last May, makes a very extraordinary statement with reference to the electric light. The main obstacle to its adoption for stage purposes, he alleges, is its unsuitability "on account of the difficulty, if not the impossibility, of partially raising and lowering the light, as required for scenic effects—a drawback which is not shared by gas." We are not aware that a difficulty of the kind referred to has been experienced in any theatre where the electric light is installed; and we are perfectly sure that no competent electrical engineer would admit that any such difficulty exists.

THE Revenue Returns just issued for the year 1887, although on the whole satisfactory, do not point to any marked revival of prosperity during the closing months. The Telegraph Service, which is as good an index to the activity of trade as any we could select, has yielded a gross revenue of £20,000 for the concluding three months in excess of that for the corresponding period of 1886, the figures being £465,000, against £445,000. Comparing the corresponding quarters of the past two years, what we have recently stated with reference to the diminishing increase of the telegraph revenue seems to be borne out, the progressive improvement in the first three quarters of the year being considerably less in 1887 than in 1886; whilst in the concluding quarter—which is always a slack time—of the year just ended, the fall in the receipts has been rather heavier than usual. It is gratifying to note, however, that in the nine months of the present financial year, the total increase on the gross receipts for the Telegraph Service has already reached £85,000.

IN connection with the use of arc lamps for large retail establishments, a very encouraging report has recently come under our notice. A tradesman who is employing the arc light in a drapery establishment in a certain provincial town stated that when the supply was unavoidably discontinued for a short time the difference in his takings amounted to a sum which we take it must have covered the entire cost of lighting for the whole year. In this case many of the neighbouring establishments were also supplied with arcs, and a centre of trade was thus created for the evening customers, so that this quarter of the town has practically monopolised the market. A further remark made was that "the use of the arc light is not with us a mere matter of school-boy preference, but an absolute commercial necessity." In this case it should be added that the lighting is of an unusually excellent description, and the establishments are mostly supplied with arcs outside or in the windows, and incandescents within.

SOME of the specimens of private enterprise in arc lighting with which Londoners are unhappily familiar can only be described as admirable illustrations of how not to do it. If the proprietors could by any means be induced to suppress these nightly displays of chromatic aberration, and return for the time to gaslights, they would confer a distinct boon upon the cause of electric lighting in general. We feel sure that they must already have deterred a large number of persons from the employment of arc lighting.

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THE fault in most of these cases undoubtedly lies neither with the lamps nor with the machines, but with the quality of the carbons burnt. There are now in the market at least half-a-dozen arc lamps which under suitable conditions may be relied on to burn a really good carbon with a steadiness approaching to perfection; but we have not yet met with a lamp capable of producing satisfactory results with inferior carbons. Nor do we see any likelihood that such a lamp will ever be forthcoming. When the nature of the problem is considered, it is perfectly clear that an infinitesimal variation in the quality or structure of the carbon must make itself unpleasantly manifest in the arc. It is not merely a question of impurity, it is also necessary to insure as nearly as possible an absolute homogeneity of structure. We do not claim that any novel view is presented in this observation, but we do think that the matter may profitably be forced upon the attention of the users of arc lamps.

IT is fortunately true that carbons closely approximating to the above description are to be obtained, but they are naturally more expensive than the inferior varieties. At a central station in the North of England which we have recently visited we were informed that the difference in the cost of supplying the arc lamps with a cheap American carbon instead of a certain make which they were in the habit of using just covered the whole cost of wages for the men employed. But the company nevertheless found it profitable—and, in fact, necessary—to adopt the more expensive article.

THE *Journal of Gas Lighting* is very angry with the Imperial Continental Gas Association for having undertaken the lighting of the Vienna Theatre by electricity, ostensibly because the Association has no right to apply the capital of its shareholders to any business not strictly its own. We are tempted to ask what is strictly the business of, for example, the Gas Light and Coke Company? To sell gas-light and coke? But we know that when paraffin threatened its business the company launched into gas-cooking stoves, to say nothing of gas engines, neither of which is related to cokeing or lighting of any kind whatever. The real ground of the *Journal's* objection, we gather from incidental observations let fall in the course of its moralising is, that if the Vienna experiment should succeed, it will do a good turn to the electric lighting business. "Is it wise," asks our contemporary, "for gas engineers to teach electricians their business?" Certainly not; and it would be still less wise for electricians to learn their business of gas engineers. But it still remains a question whether gas engineers may not study with advantage the business of electric lighting, which, after all, is more strictly in their line than some other businesses in which they have found it expedient to engage.

OWING to Mr. A. E. Kennelly's departure for America he is unable to complete the series of papers entitled "Letters for Learners" which began with the present volume of this journal. We have, however, the pleasure of announcing that the papers will be continued by Mr. H. D. Wilkinson, of the School of Electrical Engineering, Princes-street, Hanover-square. Mr. Wilkinson's first chapter appears in our present issue.

Salford.—The Lever System of Electric Lighting is being installed at the works of Messrs. Smith and Coventry, Salford.

Sir John Pender, K.C.M.G.—Our readers will be gratified to notice that among the New Year Honours the distinction of Knight Commander in the Order of St. Michael and St. George has been conferred upon the Chairman of the Eastern Telegraph Company.

Fleming's Business Diary.—Messrs. Fleming, Son and Co., of Halifax, manufacturers of oak bark-tanned leather belts, &c., send us a copy of their "Practical and Useful Diary for 1888," which publication contains a large amount of information of practical value to business men.

The Bell Telephone Suits in America.—Elisha Gray has applied for leave to amend his original specification in the American Patent Office by inserting the word "metallic" before the word "diaphragm." The Bell Company are opposing the application.

A Substitute for Mercury in Air-Pumps.—Mr. William Crookes has recently pointed out that if gallium could be obtained in sufficient quantity, it would be a perfect metal for producing vacuum in air-pumps, as it is liquid at 86deg. F., gives off no vapour, and does not oxidise.

The John Pender Gold Medal.—The John Pender Gold Medal has been gained by James Raeburn, jun., who is at present an electrician with Messrs. Ganz and Co., Buda-Pesth, as the best electrical engineering student taking the diploma of the Glasgow College of Science and Arts.

Attempted Assassination.—As M. Raynaud, Director of the Paris Telegraph School, was leaving the Ministry of Posts and Telegraphs at noon on Wednesday several revolver shots were fired at him, two of which took effect; but the wounds are not considered dangerous. The would-be assassin was arrested.

Copper-coated Carbons in America.—The Brush Electric Light Company in the United States are bringing an action against the Faraday Carbon Company for infringement of their patent for copper-coated carbons. Several other carbon manufacturers have formed a combination to defend the suit, and a good deal of interest is felt in the result.

Electric Lighting in Regent-street.—Messrs. H. J. Nicoll and Sons, whom we have before mentioned as being amongst the first to adopt the electric light, have recently adopted the "Brockie-Pell" arc lamps, which are supplied direct from a dynamo driven by a gas engine. The remarkable steadiness of these new lamps may be observed by anyone passing the establishment in the evening. A similar installation has also been fitted up at their branch house in Manchester.

Greenwich Time by Telephone.—Those of our readers who are subscribers to the Metropolitan Telephone Exchange will be pleased to hear that Messrs. Barraud and Lunds, of 49, Cornhill, E.C., have contracted with the United Telephone Company for the entire maintenance of their time system in the whole of their exchanges; and will be pleased at any time, and from any subscriber of the United Telephone Company, whether their own customer or not, to answer a "call for time," and transmit an accurate vocal Greenwich mean-time signal. Messrs. Barraud and Lunds' telephone is No. 1155.

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The Direct United States Company's "Almanack and Calendar."—We have received from the Direct United States Cable Company a "Calendar" for 1888, containing many important and interesting items in connection with submarine telegraphy. The "Calendar" contains the dates of various electrical discoveries since a very early period. The compilation of the "Calendar" must have required a good deal of labour, and we trust the Direct Company will receive the credit due to them for this publication.

Sheffield.—A malicious act was perpetrated at Sheffield on Friday last, when a cable belonging to the Sheffield Electric Light and Power Company was wilfully cut. The cable consisted of seven strands No. 18, and as the ends were clean cut at a place where it could not be reached without a ladder, it is evident that the act was a wilful and malicious one. The wire conveyed a 10-ampere current from a Thomson-Houston dynamo, and it is perhaps unfortunate that the current was not on at the time, or the perpetrator would no doubt have been discovered.

Awards at the Newcastle Exhibition.—The awards at the Newcastle Exhibition have just been made public. The only gold medal in connection with the lighting industry is that awarded to Messrs. Clarke, Chapman, Parsons and Co., for the turbo-electric generator. The recipients of silver medals for electric lighting are Messrs. Paris, Scott and Co., Norwich, dynamo machine; J. H. Holmes and Co., Newcastle, friction gear for dynamo; Dorman and Smith, Manchester, porcelain lamp holders; and Woodhouse and Rawson, London, Scharnweber's diamond arc lamps.

Annual Dinner of the Exchange Telegraph Company's Employes.—The Exchange Telegraph Company's *employés* held their first annual dinner at the Oriental Restaurant, Blackfriars, on New Year's Eve. Mr. F. Higgins (engineer) presided, Mr. W. King (secretary) occupying the vice-chair. The toasts of the evening included "The Directors of the Company," coupled with the health of the managing director, "The Chairman," and "Vice-Chairman." Some capital songs and recitations were rendered by members of the staff, and a most enjoyable evening terminated about 11:30 with "Auld Lang Syne."

The Copper Boom.—A Caution.—Messrs. J. Berger, Spence and Co., in their monthly report on the metal markets, state that they have no certain information as to the future of copper, and recommend great caution. They look to increased supplies by the impetus giving to copper mining, but in the meantime the market is in the hands of the syndicate. Large quantities of copper have been shipped over to France, where there would appear to be no increased outlet for it; and if this large quantity of copper be suddenly re-shipped to this country, a panic must ensue, and be attended by disaster to those outsiders whose tendency is to buy.

The Lighting of the Lyceum Theatre, Edinburgh.—Mr. Geipel writes us from Edinburgh as follows:—"I notice in your last issue you state that the Lyceum Theatre, Edinburgh, was electrically lighted for the first time on the night of the 26th ult. Permit me to inform you that the Anglo American Brush Corporation have lighted the auditorium and entrances to this theatre since May last. You doubtless refer to an extension of this lighting to the stage, which Messrs. Howard and Wyndham recently entrusted to the Brush Corporation, as a result of their great appreciation of the system employed. Messrs. Howard and Wyndham have also placed in the hands of the Brush Corporation a contract for lighting the Royalty Theatre, Glasgow, throughout by their system."

Extension of National Telephone Company's Trunk Lines.—The trunk wire joining the National Telephone Company's Dundee and Kirkcaldy Exchange systems has just been completed and opened for use. The length of the wire, including the cable under the Tay, is fully thirty miles. Kirkcaldy is already connected with Stirling, Alloa, Dunfermline, and other towns in that district, in addition to being in communication (through Stirling) with Glasgow and Edinburgh, each of these being more than 100 miles from Dundee as the wires go. Conversations between Dundee and each of these places were satisfactorily carried on. The completion of the Kirkcaldy trunk wire now enables not only subscribers, but also the general public in Dundee, Perth, Forfar, and Arbroath, on payment of the fee message charges, to communicate with the company's subscribers in Kirkcaldy, Dunfermline, Inverkeithing, Tillicoultry, Alloa, Clackmannan, Stirling, Bridge of Allan, Falkirk, Grangemouth, and Linlithgow. Exchanges are soon to be opened at Markinch, Leven, Cupar, &c., and these will also be in connection.

Cheltenham Street Lighting.—At a meeting of the Corporation of Cheltenham, held on Monday last, Mr. Councillor Norman proposed a resolution instructing the Streets and Highway Committee, as the committee having charge of the public lighting of the town, to report on the advisability and the practicability of introducing the electric light for public purposes in Cheltenham. In the course of a lengthy speech Mr. Norman adduced a mass of information collected from several Continental and English towns to show that electric lighting was preferable to gas lighting, on the ground that it is a better light, a healthier light, and, under certain conditions, might be made a cheaper light.—Mr. Waghorn seconded the motion, and in the course of the discussion which ensued no opposition was raised to the principle of the reference, though Mr. Lawrence desired the reference to be made to a special committee.—Ultimately it was decided to adjourn the subject till the next monthly meeting, when Mr. Lawrence will move that the words "Streets and Highways Committee" be struck out of the resolution and the following inserted instead:—"A special committee of the council, with power to call in skilled assistance if required."

Nickel Plating.—According to the *Bulletin Internationale de l'Electricité*, the following solution is employed for nickel plating by several firms in Hainault. It is said to give a thick coating of nickel firmly and rapidly deposited. The composition of the bath is as follows:—

Sulphate of nickel	1lb.
Neutral tartrate of ammonia	11·6oz.
Tannic acid with ether	·08oz.
Water	16 pints.

The neutral tartrate of ammonia is obtained by saturating tartaric acid solution with ammonia. The nickel sulphate to be added must be carefully neutralised. This having been done, the whole is dissolved in rather more than three pints of water, and boiled for about a quarter of an hour. Sufficient water is then added to make about sixteen pints of solution, and the whole is finally filtered. The deposit obtained is said to be white, soft, and homogeneous. It has no roughness of surface, and will not scale off, provided the plates have been thoroughly cleaned. By this method good nickel deposits can be obtained on either the rough or prepared casting, and at a net cost which, we are told, barely exceeds that of copper plating.

Electric Lighting in Theatres. — The views of several theatrical managers on the subject of electric lighting are set

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forth by a writer in the *Echo* as follows. It will be seen that they are of a somewhat divergent character:—"A manager who uses it not in his theatre, but in a large restaurant, and who is now preparing to put it into his theatre, says:—'In any place where more than £1,000 a year is paid for gas, electricity is cheaper. It is just as certain, too, as gas. I have had no mishap whatever with it for two years. Besides, any sudden failure can be provided against by having every chandelier or row of lights supplied by two different sets of wires coming from two different dynamos. Next, there is absolute safety. It is nonsense to talk of danger from the wires; they are as cold as ice, and there can be no fire from them, as now arranged. Again, in the matter of assurance there will be tremendous gain. Some theatres in London cannot be insured at all. Many pay as much as from £2 to £3 per cent. per annum, which on, say, an insurance of £20,000 is a heavy charge. It could be reduced to a very small sum indeed were there no gas in the theatre. My feeling is in favour of electricity, and that alone, and I mean to adopt it. Manager No. 2 said: I find that although I have electricity in my theatre I cannot do without gas. To say nothing of the chance of its going out, electricity will not warm a house, and I have had to light my gas two or three times this winter because the place was too cold without it. In the case of a new theatre this is especially noticeable, and it must be provided against. I know you will say that hot water could be used. But I do not think that there is less danger in having a big heating apparatus under a theatre than in having gas in the house only for use on emergency, or to warm the building. I question very much if the fire at the Grand was occasioned by gas. Manager No. 3 said:—Until electricity is in a much more perfect state than at present, it will be useless for big spectacular scenes, such as in pantomimes for instance. We must have gas, and we shall have to use it. But we may take all proper precautions, and it is our interest to do so. Gas for the present is a necessity."

The Durability of Gutta Percha.—Mr. H. A. Reed writes to the *Electrical Review* of New York on the above subject as follows:—"In 1849 the Merchants' Telegraph Company built a line between New York and Boston to work the Bain system. They expected to cross the Harlem River on High Bridge, but being unable to get permission to attach the wire to the bridge, Mr. Charles T. Smith, who had charge of building the line, had a No. 9 black iron wire covered with gutta percha by Mr. Samuel T. Armstrong, of Brooklyn, who was the first man to introduce gutta percha into this country, and who at that time was using large quantities of it in making pipes for water, acids, &c., and in lining tanks for various purposes. The wire was covered and laid under the supervision of Mr. W. W. Marks, the present superintendent of the Bishop Gutta Percha Company. It worked for several years, but was afterwards superseded by a more modern cable, and was forgotten until the spring of 1879, when some labourers at work near High Bridge struck with their spades something which seemed rather tough for a root, which they at first thought it to be, but on further examination found it a wire covered with gutta percha. A long piece of the wire was obtained by Mr. Marks, and although it had been buried for thirty years, the gutta percha insulation was still in good condition. I notice in this week's *Review* that the Atlantic cable, which was laid in 1869, though showing the effects of time—probably by the corrosion of its armour—is still working well. We have at our office a piece of gutta percha pipe which was laid under the East River in 1848, to convey water to Blackwell's Island, and was taken up in 1885. The gutta percha was in good condition, and was brought back at about one-half the cost of new gum, we realising a good profit on the transaction. In 1873, Mr. Marks made a 10-conductor cable, which was laid under the Capitol grounds at Washington, being buried in a trench with no protection except a wrapping of tarred tape. About three years ago the cable, which was still working, was cut in making some excavations, and Mr. G. C. Maynard, who repaired it, sent us a sample to show that the cable was then as good as new. Another 'proof of the pudding by eating' is that we and others pay 40 cents per pound for the gutta percha stripped from the cores of Western Union cables, after they have been used long enough to completely destroy the armour. This material is not used a second time for insulation, but answers well for some other purposes."

Lectures on Electricity by a Lady for Ladies.—A course of six elementary lectures on electricity will be given by Mrs. Ayrton at 2, Upper Phillimore-gardens, W., on January 17th, and the five following Tuesdays, at 5:15 p.m. The course, which will be fully illustrated by experiments, will be strictly elementary, and will pre-suppose no scientific nor mathematical knowledge. Tickets for the course may be obtained by letter from Mrs. Hancock, hon. sec., 125, Queen's-gate, S.W., to whom application should be made before January 13th. Single tickets £1. 1s.; to admit six £4. 4s. The following is the syllabus:—January 17th, What Electricity can do for us.—(1.) In our households—Lighting, ringing bells, winding clocks, working machines, such as sewing, boot cleaning and plate cleaning machines, telephony. (2.) Out of doors—Lighting large spaces, fire alarms, driving tricycles, cabs, tramcars, trains, launches, transporting goods. (3.) In our manufactories—Electro-plating, electro-typing, purifying metals. January 24, The Different Ways of Obtaining a Supply of Electricity.—Electricity among the Greeks; Galvani and Volta's discovery of the electric current; galvanic batteries; energy—its different forms; the conservation of energy; the purposes for which galvanic batteries are economical—bells, signals. January 31st, Faraday's discovery.—How to Produce Large Currents.—Electric pressure or potential. The difference between a good conductor, such as copper, and an insulator such as gutta percha; importance of good insulation to prevent accidents and waste; lighting of Grosvenor Gallery, St. James's Hall, &c., by the Grosvenor Gallery Electric Supply Association; the distance through which large currents can be sent; Deprez's installation 37 miles; the storage of electric energy. February 7th, Electric Lighting for Houses.—Incandescent lamps, how they are made; the cost of lighting (1) a dinner table, (2) a ball room, (3) a house with incandescent lamps for one evening; the cost of lighting a house permanently with incandescent lamps; the Electric Lighting Act, how it has impeded the use of electricity in England. February 14th, the Physiological Effects of Electricity.—Galvani's experiment with the frog; need for scientific precision in the application of electricity to the cure of disease; an electric hospital; why lightning is dangerous; why trees should be avoided in a thunderstorm; lightning conductors worse than useless unless properly constructed; points to observe when they are put up. February 21st, Transmitting Messages, Music, and Song by means of Electricity.—The telegraph; submarine cables; the telephone; the microphone, or sound magnifier; the phonograph; seeing by electricity—can it be accomplished? the future of electricity. We may add that Mrs. Ayrton is a graduate of Girton College, Cambridge, has been a pupil at the City and Guilds of London Finsbury Technical College, and is now a pupil at the Central Institution.

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SOME ENGLISH CENTRAL LIGHTING STATIONS.

II.—BRADFORD.

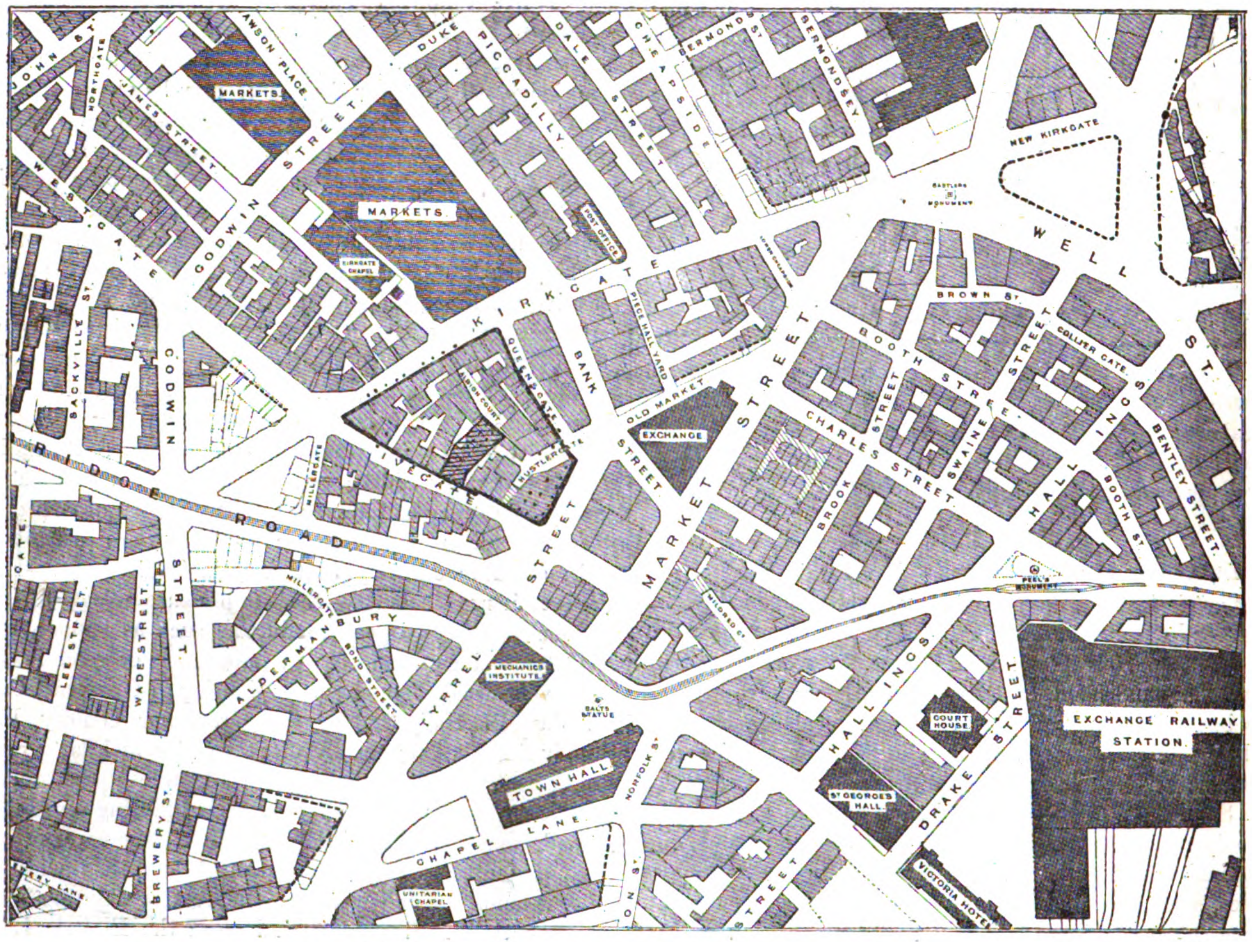
It is not our present intention to make any further reference to the negotiations between the Corporation of Bradford and the local company which is already engaged in the business of central station lighting in that town; but having recently paid a visit to the works of Messrs. Schmidt-Douglas and Co., we propose to give a brief account of the station and of the facts connected therewith which have come under our notice. We may, however, remark at the outset that we have been very favourably impressed with the character of the work, which we cannot but regard as one of the finest specimens of electrical engineering at the present time to be found in this country. The excellence of the arc-lighting is especially noticeable, nothing finer having at any time come under our notice. The only subject for regret in this connection arises from the fact that the dynamos, lamps, and carbons are all of foreign manufacture.

they erected two high-pressure quick-speed engines to drive two compound dynamos yielding current for about 150 incandescent lamps and 20 arc lamps.

This installation having proved a success, both consumer and supplier being perfectly satisfied with the results, it was decided during the summer of 1887 to alter the works for the purpose of erecting a central electric lighting station on an extensive scale.

Application was therefore made to the Corporation with a view of obtaining permission to carry the wires either over or under the adjacent streets. The company were prepared to pay a royalty upon each lamp so supplied in recognition of the powers held by the Corporation; but the negotiations ultimately fell through, the parties being unable to come to terms.

Messrs. Schmidt-Douglas, wisely or unwisely, nevertheless determined to proceed with their preparations for undertaking the supply of current upon an extended scale, and their plans were laid out under the expectation of ultimately developing about 5,000 horse-power. The old buildings, occupying an area



PLAN OF CENTRAL DISTRICT OF BRADFORD

Showing the area lit by the Schmidt-Douglas Company. The works will be seen between Ivegate and Albion Court. The dots represent arc lamps.

The adjoining plan represents the central portion of the town of Bradford, and it will be seen from this that the station is situated in the heart of the town; the town hall and municipal offices, the Exchange, Railway Station, extensive markets, principal clubs, and other public buildings all lie within a narrow circle, of which the station is approximately the centre. The most important retail shops are also in the immediate neighbourhood, so that if the supply were restricted to a low-tension direct-current distribution, it would be impossible to select a more favourable situation.

The commencement of the work dates back only to the summer of 1886, when Messrs. Schmidt-Douglas and Co. commenced to supply the electric current for lighting purposes to a few shops and to some of their friends having places of business round about their works at Hustlergate. For this supply

of 750 square yards, were partially removed, and the foundations were laid of a substantial structure suited for the employment of heavy machinery on the upper floors. The bottom floor, intended for the engine room, rests on the solid rock. The boilers were to be on the street level, and the dynamos on the first and second floor above. A sectional elevation of the building is shown in Fig. 2.

The building is constructed of compound steel girders composed of two 7in. by 9in. single girders and riveted together top and bottom with ⅜in. steel plate. These girders run the whole width of the building, and are supported by iron pillars 10ft. high, the end pillars being walled in. Between each length of girder are filled cross girders 4in. by 7in., 2ft. apart, and between each of these cross girders are double-brick arches. All the floors are concreted, forming one solid

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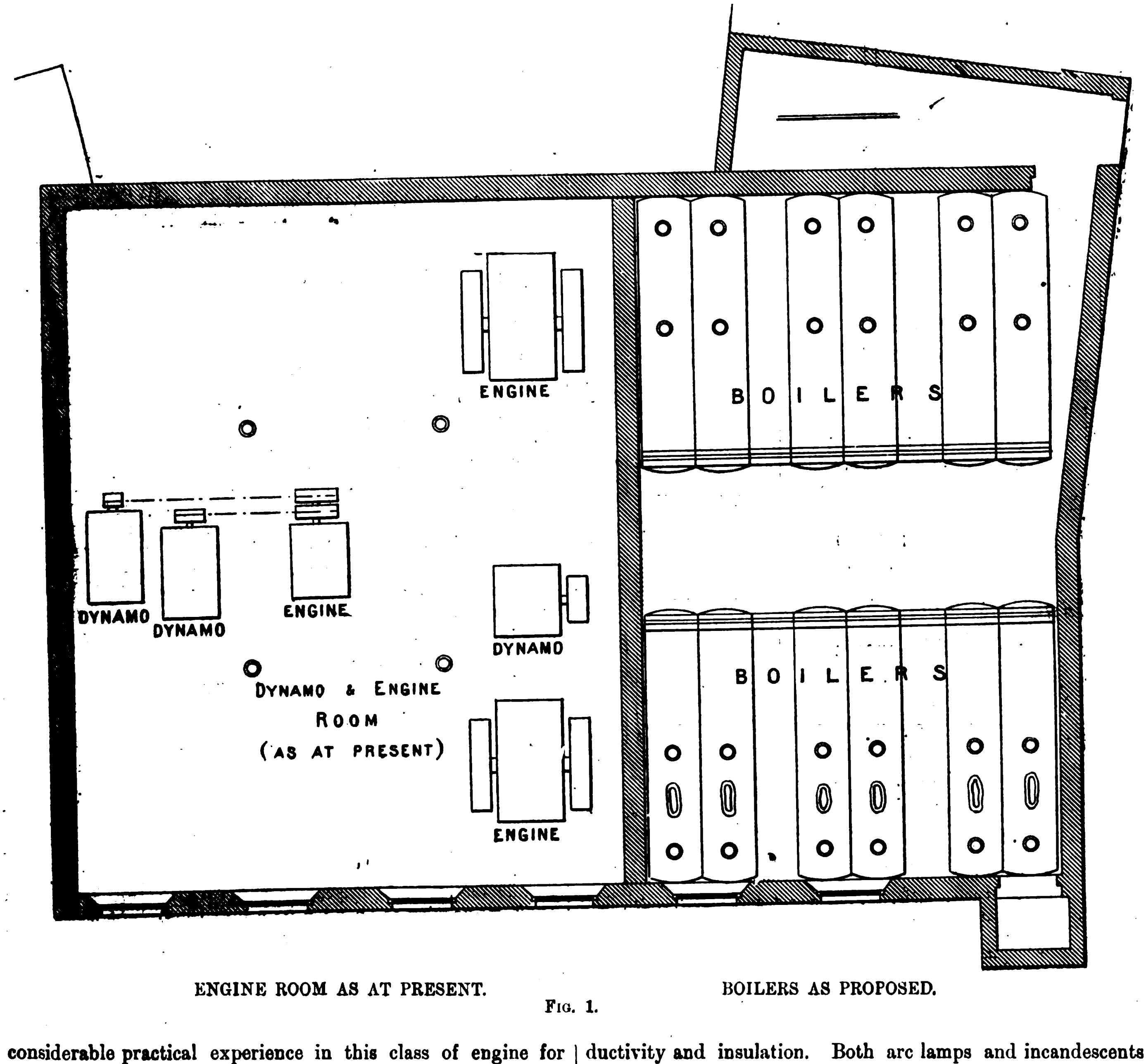
fireproof mass of building in every way suitable for the erection of heavy machinery.

Great consideration has been given to the production of steam by the most modern and economical means at command, and the smoke from the furnace is entirely consumed. Only one boiler has yet been brought into use, although two are in position. They were supplied by the Babcock and Wilcox Company, and are on the high-pressure system, steam being taken from the boilers between 100 and 150lbs. pressure. The boilers are set to blow off at 200lb., and are supplied with water from the town mains, by Worthington's high-pressure steam rams, and also by exhaust injection, either source of supply being employed at will. The engines have been specially constructed by Messrs. Browett and Lindley, who have had considerable practical experience in this class of engine for electric lighting. Three engines are at present in position, of which one is spare. The engines are vertical, side-by-side compound, being fitted with Lindley's high-speed governors. Messrs. Schmidt-Douglas speak very highly of this governor, which they find to be very reliable and efficient, governing well with a steady or variable load. The engines are fitted with automatic oiling arrangements. Two dynamos are at work with one spare machine; they are by Schuckert, of Nuremberg, and were specially built for this station, and are compound-wound. At the time of our visit the machines were running very cool, and were entirely free from sparking. Each machine is fitted with a Schmidt-Douglas bulb-drop, sight-feed lubricator, and also with a Schuckert voltmeter and pilot lamp. The dynamos are at present fixed in the same room as the engines, the arrangement being as shown in Fig. 1. Each machine is driven by a 12in. leviathan belt, specially constructed by Hebblethwait Bros., of Huddersfield. We were informed that these belts have given great satisfaction. Each dynamo is fixed on timber foundations, securely bolted to the floors, and care has been taken that the machines shall be thoroughly insulated from the ground. Belt tightening gear is fixed to each dynamo. At present the total production of current amounts to 1,000 amperes at 110 volts.

The cables used are of high quality both as regards conductivity and insulation. Both arc lamps and incandescents are run on the same circuit, the arcs being connected two in series across the parallel.



ENGINE ROOM AS AT PRESENT. BOILERS AS PROPOSED.

Fig. 1.

The wiring of the consumers' premises has evidently been carried out with great care, the Phœnix Fire Office rules being observed in every respect. The arc lamps are also by Schuckert, and although as regards steadiness and colour we have occasionally seen an equally good performance elsewhere, we are bound to admit that we have never at any time seen anything better. The excellence of the result attained is due in large measure to the quality of the carbons consumed, which are of German manufacture.

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The tariff charged by the company is at the average rate of £1 per month for arcs and 4s. per month for incandescent lamps, but depends upon the number of lamps supplied. No other charges are made, and the fittings are supplied and fixed by the company. The number of lamps in use at the present time is about 60 arcs and 200 incandescents, and very nearly the whole of the block which can be reached without crossing the streets has already been supplied.

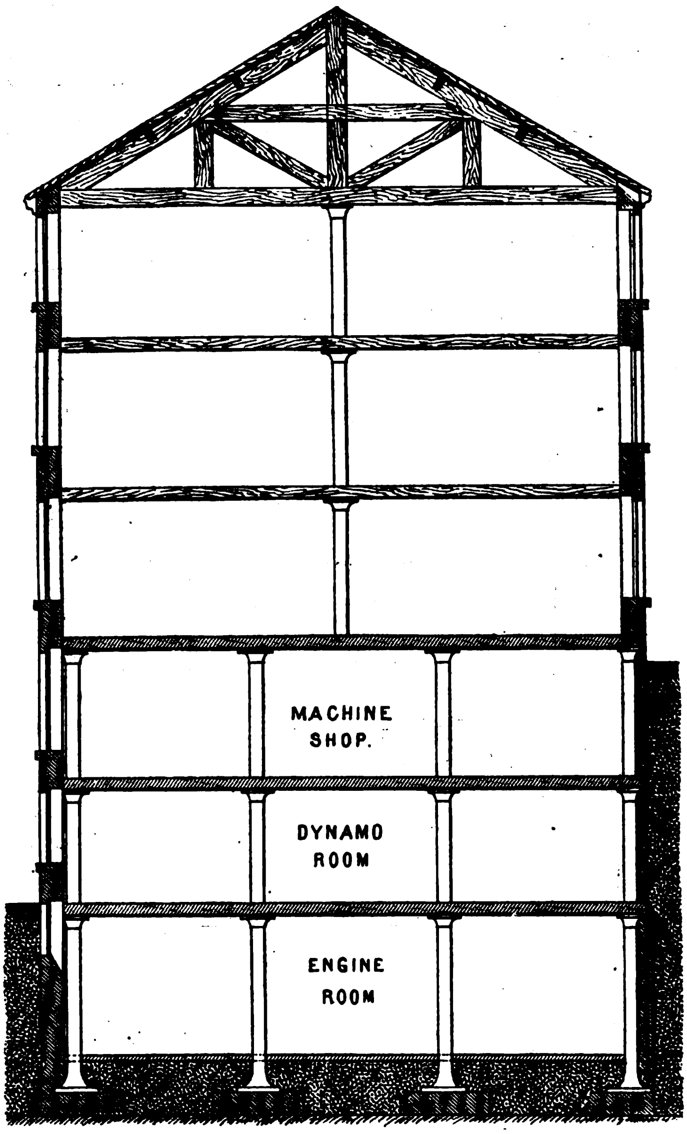

Fig. 2.—Section of building as proposed. The first three floors only are at present built.

Taken as a whole the installation does very great credit to the engineers of the company, and its inspection will well repay a visit to Bradford.

PORTABLE VOLTMETERS FOR MEASURING ALTERNATING POTENTIAL DIFFERENCES.

BY W. E. AYRTON AND JOHN PERRY.

It is now well understood that a high-resistance electrodynamometer cannot generally be used for measuring alternating potential differences, in consequence of the self-induction of the dynamometer causing the effective resistance—and therefore the sensibility—of the dynamometer to vary with the speed of alternation. Further, even for the measurement of direct potential differences an ordinary high-resistance voltmeter, employing the magnetic property of the current, is not entirely satisfactory if the forces employed be large (as they generally have to be in dead-beat portable instruments), since, in that case, the current, if kept continuously on, slowly heats the voltmeter, and by increasing its resistance causes its sensibility to diminish. It has, therefore, for some time seemed clear that the heating effect of a current should be used for voltmeters.

Captain Cardew was the first person to utilise this principle in the construction of voltmeters, and, as far as we are aware, is the only person who, up to the present time, has employed the extension of a wire caused by the heating produced by the passage of a current to measure the potential difference at its terminals. His instruments are well known, and have afforded most valuable aid in the measurement of alternating potential differences; and we, in common with other electrical engineers, owe him a debt of gratitude for providing us with the only commercial instrument that has existed for the measurement of alternating potential differences.

In "Practical Electricity" an attempt has been made to impartially sum up the advantages and disadvantages of all the more important ammeters and voltmeters, and we cannot do better than repeat what was there said about the Cardew voltmeter, especially as we understand that Captain Cardew considers the criticism to be a fair one.

"CARDEW VOLTMETER.

"*Advantages.*—First, it has but a small heating error; second, the self-induction is negligible. It is also dead beat, direct-reading, not disturbed by magnets, and fairly portable, although large.

"*Disadvantages.*—It absorbs a good deal of energy; second, it cannot be used for measuring a small potential difference, for we cannot make it of thicker wire, as we should do in the case of an ordinary voltmeter intended to measure small potential differences, as this would render it sluggish, since a thick wire traversed by a current heats and cools slowly on starting and stopping the current; third, there is considerable vagueness in the readings near the zero point, and sometimes inaccuracy in the upper parts of the scale."

Towards the end of 1885 we were engaged on certain experiments on the governing of transformers in series to give a constant potential difference at each house, and, as our experiments were to be conducted with small transformers, we required a voltmeter which would measure an alternating potential difference of three or four volts with accuracy. Such an instrument not being in the market, we were compelled to devise one, and we were led to consider whether the Cardew principle might not be employed in an instrument which should give quite definite readings even near the zero, and produce a large deflection when an alternating potential difference of a few volts was maintained between its terminals.

Part of the vagueness in the readings of the Cardew instrument we saw was due to the employment of toothed wheels; and, as explained in a paper* read by us before the Royal Society in 1884, toothed wheels have not recommended themselves to us as a means of magnification in ammeters and voltmeters, in consequence of the friction they are liable to introduce. In fact, after giving toothed gearing an extensive trial in our instruments, originally described to this Society† in 1882, we decided to abandon its use in 1884.

If a voltmeter depending for its action on the expansion of a wire by heating is to be sharp in its action, the wire must be fine; and if it is to measure a small potential difference the wire must be short; hence we were led to consider whether it was not possible to construct a voltmeter of quite a short length of fine wire, and observe its extension with some frictionless magnifying arrangement. This led us to consider the platinum wire telephone described by Mr. Preece in his paper‡ read before the Royal Society in 1880, which, although composed of but a short length of wire, evidenced by the motion of the diaphragm, to the centre of which one end of the wire was attached, every change in the current passing through it. After thinking out various means of attaining this result, we

* "A New Form of Spring for Electric and other Measuring Instruments."
† "Measuring Instruments used in Electric Lighting and Transmission of Power."
‡ "Thermal Effects of Electric Currents."

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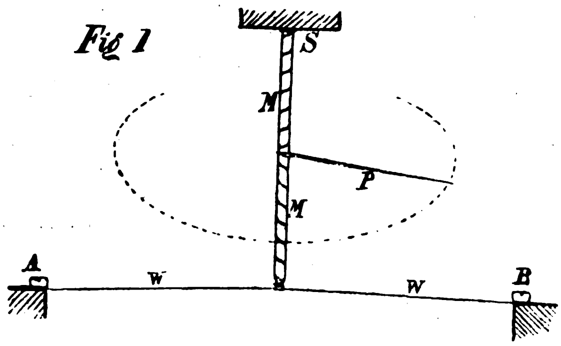
were led to see that one of our magnifying springs, described to this society in 1882, furnished the means of obtaining a sufficiently sensitive frictionless magnifying arrangement. For experiment shows that if a short piece of fine wire W W (Fig. 1) only seven inches long be stretched between two sup-

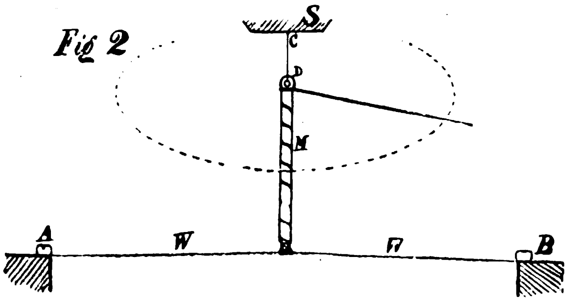
Fig 1



ports A and B to which it is *rigidly* attached, and if it be pulled slightly out of the straight line by one of our right and left handed magnifying springs M, *rigidly* attached at its one end to the wire and at the other to a support S, the axes of the spring and the wire being at right angles to one another, the arrangement is so delicate that the expansion produced by even the approach of a warm hand is evidenced by the rotation of a pointer P attached to the centre of the right and left handed magnifying spring. The absence of all gearing and the rigid fastening of both ends of the spring, combined with the fineness of the wire, make the arrangement remarkably dead-beat in its action; and when the wire is enclosed in a short metal tube we have a voltmeter which will measure even the fraction of a volt, whether the potential difference be direct or alternating, since the readings even near the zero are quite definite.

The right and left-handed spring was employed to avoid any twist being given to the wire; but one of our assistants, Mr. Bourne, who has worked at this instrument with his customary ingenuity and dexterity, soon found out that half the length of the spring could be dispensed with, and an equally efficient but much more compact arrangement could be effected by using a single ordinary magnifying spring M (Fig. 2), and

Fig 2



introducing a small piece of fine wire C D between the one end of the spring and the stretched wire W W, or between the other end of the spring and the support S.

To get extreme quickness of action on changing the potential difference, it is desirable to employ a thin wire; and as the strength of such a wire is small, the next step was to combine a number of wires mechanically in parallel, and electrically in series or parallel, the wires being attached at their middles to a stirrup which is carried by the magnifying spring; and voltmeters containing as many as twelve short wires, each about seven inches long, were made in the early part of the summer of 1886.

These instruments showed, however, the sluggishness which is familiar to the users of the Cardew voltmeter, and we had to set ourselves to investigate it. Stationary metallic screens were inserted between the wires to assist the cooling, and various other means tried without success, when we set Mr. Bourne to investigate the general question of sluggishness. A variety of experiments were made by him on the rate of variation of the permanent state of a wire with the variation of potential difference at its terminals, as affected by varying the proximity of the wires, their length, &c. This occupied him several weeks, and the experiments he made were too numerous to be recorded here. With our many-wire voltmeter the sluggishness was certainly not due to mechanical friction, as our magnifying spring is practically frictionless; and we gradually saw that the peculiar creeping back in the deflection of a Cardew voltmeter when a perfectly constant potential difference was first set up between the terminals was due to the fact that the draught of air created in the tube by the heated wires takes an appreciable time to be produced, so that the wires are hotter directly the potential difference is applied than they become when the draught begins to flow. A number of more or less successful devices were tried for overcoming this defect—for instance, even the employment of a draught independently maintained—when we found in the summer of last year that the simple device of placing the tube horizontal instead of vertical, and using very fine wire—not much exceeding one-thousandth of an inch in thickness—overcame all the difficulty. The importance of placing the tube horizontal was also subsequently seen by Mr. G. S. Ram this year, and consequently the scales of the Cardew voltmeters are now marked so that the zero is at the top when the tube is placed horizontal.

Fig 3

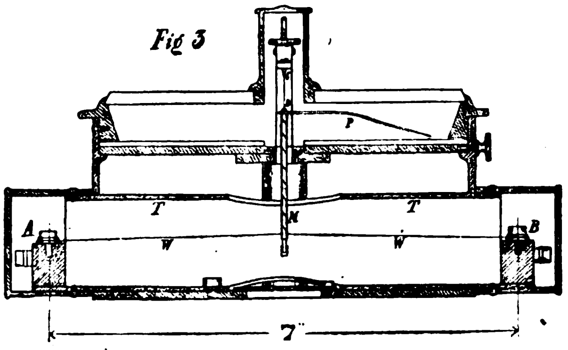
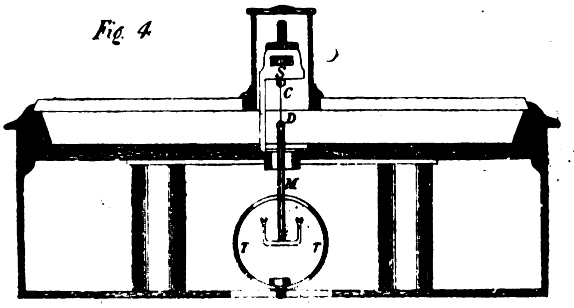


Fig 4



This home-made instrument with two wires lying on the table was then completed in August of last year, and was found to be remarkably sharp and decisive in its action—to give a deflection of 300deg. with 14·22 volts maintained at its terminals. Even a fraction of a volt can be measured with it, as the readings are quite definite even near the zero.

The finest wire employed by Captain Cardew in his commercial instrument has a diameter of 0·0025 of an inch; but, in consequence of our magnifying gearing being frictionless and comparatively massless, we are able to use much finer wire—not more than 0·0014 of an inch in diameter—without any fear of injury, even if the instrument receive a sharp knock. This greater fineness of the wire gives us three times as much resistance per foot, and therefore enables the instrument to be very much smaller; also, as the ratio of surface to sectional area is far greater, the heating and cooling is far more rapid—that is, the instrument is much more dead-beat.

Figs. 3 and 4 show two sections at right angles to one another through the centre of this other two-wire voltmeter which is lying on the table. It has been constructed on the

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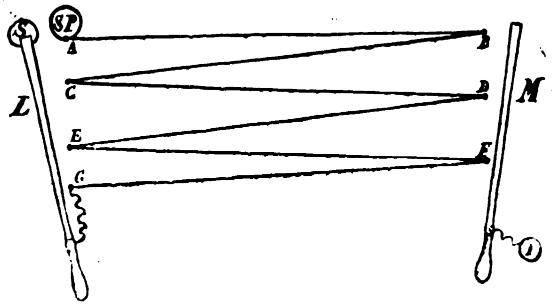
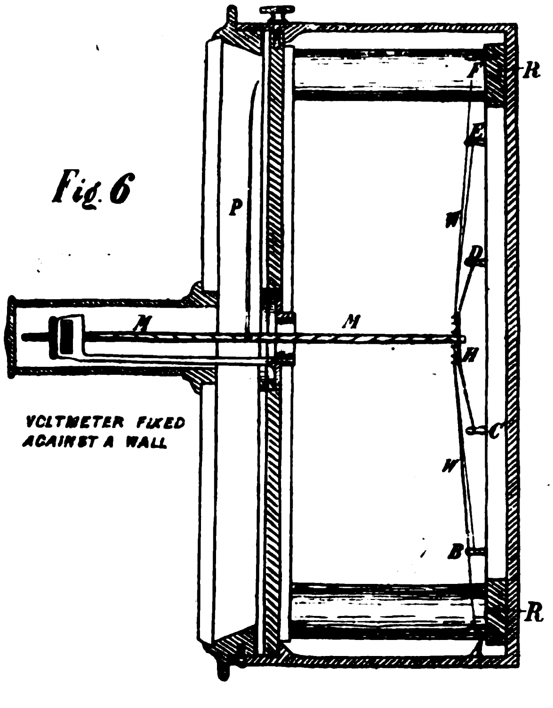
lines of the original one, but in a more workmanlike manner. It is direct-reading, and measures from 0 to 10 volts, the deflection for that potential difference being some 250deg. The same letters are employed to designate the various parts of the instrument as were used in Figs. 1 and 2, with the addition of T, the metal tube surrounding the wires; and the stirrup connecting the end of the magnifying spring with the wires is also shown.

Fig 5



The employment of several short parallel wires soon suggested the addition of the commutator described in our paper read before this society in 1881, for varying the sensibility of a voltmeter. But whereas with our commutator ammeters and voltmeters in which the magnetic action of a current in deflecting a magnetised needle was employed the current had to flow through every wire in the same direction, whether the wires were joined in series or in parallel, with this new form of voltmeter in which the heating property is employed it is

Fig 6

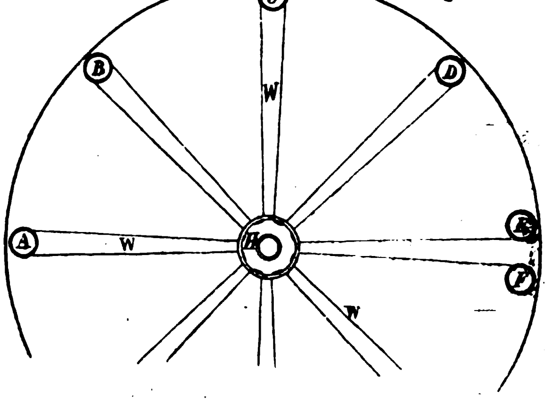


unimportant which way the current passes through a wire. Hence the pins in the barrel of our old commutator which gave trouble may be entirely dispensed with, and the commutator assumes a very simple form. In fact, if A B, B C, C D, D E, F G (Fig. 5), represent wires joined in series in the new form of voltmeter, the series connections need not be disturbed when a parallel arrangement is required, since all that need be done to join them in parallel is to connect the points A, C, E, G, by means of the bar L, and B, D, F, by means of the bar M. S and S P are the terminals for series and P and S P for parallel, so that if the commutator be accidentally turned from series to parallel the circuit is broken and the wires are not fused. This instrument lying on the table is a four-wire voltmeter, and the sensibility is such that 15·2 volts gives a deflection of 39deg. when the commutator is turned to series, and 295deg. when it is turned to parallel.

It is important to notice that the employment of this commutating device to vary the sensibility enables all the wire in the instrument to be always operative in deflecting the pointer; whereas, if the ordinary device of adding an outside resistance coil be employed to enable the voltmeter to measure a larger number of volts, the energy spent in heating this outside resistance coil is entirely wasted as far as deflecting the pointer is concerned; in fact, the greater the outside resistance, the more inefficient becomes the voltmeter.

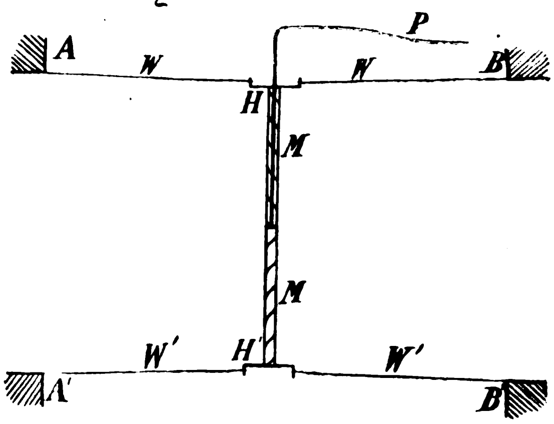
For the object of still more completely carrying out the principle of employing a number of short wires we have also made voltmeters in the following way:—The wires are arranged like the spokes of a small bicycle wheel W W

Fig 7



(Fig. 6); that is, we have a circular rim of a wheel, R, which may be of the same metal of which the wires are made, to eliminate errors due to change of temperature, fitted with non-conducting studs A, B, C, D, &c., to which the wires are attached. There is also a small non-conducting central piece, H, corresponding with the hub of a wheel, to which the wires are also attached; and as the wires come from rim to middle backwards and forwards several times, the arrangement

Fig 8.



appears like a bicycle wheel with many spokes, as seen in Fig. 7. One end of a right and left handed magnifying spring M (Fig. 6) under tension is rigidly attached to the hub H, and its other end to the support S. Hence, as the wires expand on heating, the spring draws the hub H more out of the plane of the rim, and the rotation of the pointer P measures the current. R is a metallic plate put between the two bicycle wheels to assist in the cooling. This instrument on the table is made exactly in this way. Using two of its three terminals the range is from 0 to 50 volts; or using one of the previous ones and the third, it is from 0 to 100 volts. In both cases, however, the whole of the wire is operative in deflecting the pointer.

Fig. 8 shows a voltmeter made with two bicycle wheels.

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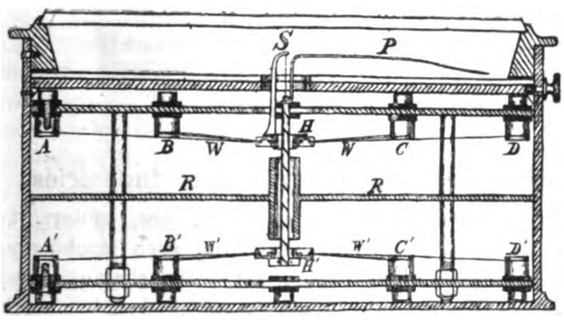
The letters attached to one of them refer to the same parts as the letters used in Fig. 6, while similar accented letters are used for the similar parts of the second bicycle wheel. As before, one end of the right and left handed magnifying spring is attached to the hub of one of the wheels, but instead of the other end being rigidly attached to the case of the instrument it is attached to the hub of the other wheel. Hence the rotation of the pointer is produced by the expansion of all the wires on both wheels. Fig. 9 shows the actual arrangement of the double bicycle-wheel voltmeter on the table, where an ordinary (not a right and left handed) magnifying spring M is employed, with a flexible connection of fine wire carried by the support S, which itself is carried by the hub H of one of the wheels. The wires are electrically divided into four sets. When the commutator is turned to series, 80 volts produces a deflection of 300deg.; whereas 20 volts produce a deflection of 300deg. when the commutator is turned to parallel.

Fig 9.



In Fig. 6 of the single bicycle-wheel voltmeter the instrument is shown with the dial vertical. But any one of the forms described in this paper may also be used with the dial either horizontal or vertical.

(To be continued.)

ELECTRIC TRACTION CALCULATIONS.

The following table will be found very useful in making calculations connected with electric (or other) traction :—

TABLE

Giving Miles per Hour, in Feet per Minute and per Second.

Miles per Hour.	Feet per Minute.	Feet per Second.	Miles per Hour.	Feet per Minute.	Feet per Second.
1	88	1·46	16	1,408	23·47
2	176	2·93	17	1,496	24·93
3	264	4·4	18	1,584	26·4
4	352	5·87	19	1,672	27·86
5	440	7·33	20	1,760	29·33
6	548	8 8	21	1,848	30·8
7	616	10·26	22	1,936	32·26
8	704	11·73	23	2 024	33·72
9	792	13·2	24	2,112	35·2
10	880	14·67	25	2,200	36·67
11	968	16·13	26	2,288	38·14
12	1,056	17·6	27	2,376	39·6
13	1,144	19·07	28	2,464	41·04
14	1,232	20·52	29	2,552	42·50
15	1,320	22·	30	2,640	44·0

Formula for calculating the horse-power required to propel any vehicle—

$$\text{H.-P.} = \frac{W K S}{33000} \pm \frac{W\,2240\,S}{33000} \sin\theta.$$

where W = total rolling load in tons,
K = resistance to motion expressed in lbs. per ton,
S = speed required in feet per min.,
θ = the inclination of the grade.

The value of S corresponding to any number of miles per hour can be filled in from the table. K can only be determined by experiment, but approximate values can be found in the usual text books. For raised rails K varies from 12·5lbs. to 20lbs.; for sunk rails, from 28lbs. to 56lbs. will be fair limits under ordinary working conditions. On inspection, it will be seen that the first fraction in the equation gives the horse-power required to overcome the resistance to traction on the level only, while the right hand quantity is a measure of the work done either against or by gravity; hence the double sign. The term will be negative on a down-grade, and positive on an up-grade. If the *gravity* term exceed the *traction* term and have a negative sign, the equation becomes negative. This means that the car will travel by the aid of gravity alone. The use of the table and formula will be best seen from an example :—

Let K = 30, W = 8 tons.
Speed = 10 miles per hour,
$\therefore$ S = 880.

And, let $\sin\theta = \frac{1}{50}$;
or, $\theta = 1^\circ\ 9'$.

Suppose the gradient is against the load, we have

$$\text{H.-P.} = \frac{8 \times 30 \times 880}{33000} + \frac{8 \times 2240 \times 880 \times 1}{33000 \times 50}$$

$$= 6{\cdot}4 + 9{\cdot}5 = 15{\cdot}9.$$

A. T. SNELL.

MEETINGS OF SCIENTIFIC SOCIETIES.

(Week ending Thursday, 12th January.)

SATURDAY, January 7th.

ROYAL INSTITUTION.

3 p.m. The last of the Series of Six Lectures on Astronomy. By Sir ROBERT STAWELL BALL, LL D., F.R.S.

MONDAY, January 9th.

INVENTORS' INSTITUTE.

8 p.m. Ordinary Meeting.

TUESDAY, January 10th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Paper, "The Use and Testing of Open-Hearth Steel for Boiler Making." By the late HAMILTON GOODALL, A.M.I.C.E. And Monthly Ballot for Members.

WEDNESDAY, January 11th.

SOCIETY OF ARTS.

7 p.m. Juvenile Lecture II. "The Application of Electricity to Lighting and Working." By Mr. W. H. PREECE, F.R.S.

THURSDAY, January 12th.

THE ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

8 p.m. Presidential Address by Mr. EDWARD GRAVES.

*** Particulars of meetings to be held or papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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1887.

The Electric Light and Power Industries.

In the construction of dynamo machines, motors, transformers, and the practical application of such machinery, the year 1887 gave birth to no very remarkable novelties. As a matter of fact, the manufacture of dynamo machines has already settled down into the lines of a well-established business, and the leading firms have therefore no reason to abandon types which have secured the favour of users for new and more or less fanciful shapes. Generally speaking, the present tendency is, and has been for more than a year, to adopt the single horseshoe field-magnet, and firms like Messrs. SIEMENS and Messrs. ELWELL-PARKER, who originally made double horseshoe machines, have adopted the single horseshoe field almost exclusively for continuous-current dynamos. Messrs. CROMPTON adhere, however, still to the double horseshoe field for large dynamos, and Messrs. MATHER AND PLATT have retained their "Manchester" type, which is also of the double horseshoe pattern. It is generally admitted that a single horseshoe magnet requires less exciting wire and a smaller expenditure of energy to produce a given field than one of the double horse-shoe form; but the latter, especially when of the "Manchester" type, has the advantage of small weight, cheapness of construction, great simplicity, and solidity. Taking electrical and mechanical advantages into consideration, they appear to be pretty equally balanced between the two designs. When, however, high efficiency is of greater importance than low cost, the single horseshoe machine is evidently preferable. As regards the material for field-magnets, it is curious to note that in some instances cast iron has been reverted to during the past year. In the early days of heavy electrical engineering cast iron was employed either for magnet cores or for pole-pieces in many of the dynamos which then were most in favour. Thus the Weston, Hochhausen, Bürgin and other machines had cast-iron magnets. When the laws of the dynamo began to be better understood, and when it was recognised that by the employment of wrought-iron magnets of the same size the electromotive force of the machine could be increased by about 40 per cent., this material was at once adopted, and cast-iron magnets were considered a thing of the past. But in this sudden reversion to the more expensive material the makers

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overlooked the fact that cast-iron magnets could be made just as efficient as wrought-iron ones, provided the sectional area be sufficiently increased. Now, an increase of sectional area means an increase in the length of the convolutions of the existing coils and an increase in weight. These are undoubtedly disadvantages, but, on the other hand, some saving can be effected in labour and in the prime cost of the magnets, besides the advantage of a machine containing fewer parts. Whether these advantages are sufficient to make up for the disadvantages of cast-iron magnets depends on the relative price of cast and wrought iron, on the cost of labour, on the price of copper, and on some local circumstances. With copper at its present price, and when well annealed magnet forgings can be had for something like 16s. or 17s. per cwt., it is probable that it will not pay to use cast iron; but whatever may be the economic aspect of the question it is interesting to note that more than one firm has made machines with cast-iron magnets. We have recently described a machine of this description built by Messrs. PARIS AND SCOTT. Messrs. PATERSON AND COOPER have also brought out a single horseshoe machine, in which the pole-pieces, magnet limbs, and a portion of the yoke are in one casting. The remainder of the yoke and the bed-plate form another casting. In this machine the armature is above, and its spindle is supported in two bearing standards bolted to the bed-plate. The magnets have not been cast with the bed-plate because of convenience in handling, but even with the horizontal joint dividing that portion of the yoke which is cast with the magnets from that which forms part of the bed-plate, the amount of tooling required in this machine is reduced to a minimum. The joint is naturally of large area, and being traversed by only a portion of the lines offers, therefore, less magnetic resistance to the total flow than the usual construction, where each magnet limb is separately bolted to the yoke. Cast-iron field-magnets are also employed in Mr. PARSONS' turbo-electric generator, though in this case the material was chosen not so much for economic reasons, as because with the high speed of the armature, strength of field is not so much a necessity as in the ordinary type of dynamo. As we have recently described and illustrated this machine we need not dwell upon it at the present time, beyond recording the fact that a fine battery of these generators was at work with perfect success during the Newcastle Exhibition, lighting nearly the whole of the buildings by means of Parsons' large glow lamps. Owing to their compact arrangement and small weight, these generators find much favour with marine engineers for ship lighting.

As regards the armatures of continuous current dynamos, the present tendency is towards a more universal adoption of the drum type. So long as the Hefner-Alteneck patent was in force, not many makers did care to adopt a type of armature on which they would have had to pay royalty, but with the expiration of this patent the use of the drum-winding was thrown open to the public, and some of our leading makers have during the year built dynamos having such armatures. Messrs. ELWELL-PARKER showed a vertical single horseshoe dynamo, with drum armature, at the Newcastle Exhibition; and Messrs. GOOLDEN have adopted long drum armatures for some of their direct-driven dynamos. Messrs. PARIS and SCOTT have also brought out some two and four-pole machines, having a modified drum armature. A good deal has been said and written regarding the relative advantages of cylinder and drum armatures, but most investigators have limited themselves to what may be called the more elementary considerations of length of wire per volt, resistance and facility of manufacture and repair. There are, however, some other points involved, which, although of some importance, seem to have hitherto escaped general notice, and as the present tendency is towards the adoption of drum armatures in preference of the cylinder type, a few words on the subject may be of interest. In the first place, it is well to notice that with the exception of EDISON and WESTON, dynamo makers generally have not adopted the type of armature originally introduced by Messrs. SIEMENS, as long as that firm could demand a royalty for use of the drum-winding. This winding was only taken up by some of the leading makers after the time for demanding royalties had elapsed. It would therefore appear that the possible advantages of drum-winding were not sufficiently great to induce firms to adopt the method as long as there was anything to pay for it. But even a small advantage, if it can be obtained without sacrifice in another direction, is worth having, and that the drum is in some respects better than the cylinder is pretty generally acknowledged. The greatest objection to drum-winding has hitherto been the difficulty of repair. If a coil burns up in a cylinder armature it can be replaced without disturbing the rest of the winding, but in a drum the whole of the winding must generally be removed before the repair can be effected. As time goes on this objection, however, loses much of its original force. The workmanship and materials now used in dynamo construction have been so far improved that a short circuit in a single coil is now a very unlikely thing. We do not say that a breakdown will never occur with modern machines, but it is more likely to be of a mechanical character than a local failure of insulation; or if it be an electrical breakdown it is more likely to be due to rough usage, affecting more or less the whole machine. In such failures the greater accessibility of any single armature coil is of comparatively little importance. But granting that the cylinder has still some advantage over the drum in this respect, the latter has the advantage of a larger mass of iron and a smaller self-induction, besides requiring less wire. Owing to nearly the whole of the interior of a drum armature being available for the flow of lines, the density of lines need not be so great as in a cylinder core, thus reducing the liability to heat, and economising power, whilst the smaller self-induction and reduced length of wire permits larger currents to be given off without sparking at the brushes or excessive heating of the conductor. Thus weight for weight a drum machine will have more output than a cylinder machine. This advantage, in our days of keen competition, cannot fail to attract the serious attention of dynamo makers, and we may therefore expect that during the year upon which we are now entering dynamos with drum armatures will come largely into favour.

It is curious to note that whilst other makers have thus taken the drum armature, Messrs. SIEMENS AND HALSKE, of Berlin, who originally introduced it, have begun to abandon it in favour of the Gramme ring. During the year a type of dynamo has been developed in Germany which necessitates the employment of the Gramme armature, whilst, at the same time, reducing the total weight of machine to even a larger extent than can be accomplished by the substitution of the drum for the cylinder in the usual two-pole machines. We refer to multipolar cylinder machines with internal magnets. Priority of the invention, if such it can be called, is claimed by four German firms, viz., Mr. FEIN, Messrs. SIEMENS AND HALSKE, Messrs. GANZ AND CO., and the HELIOS COMPANY. Briefly described, the machine consists of a fixed star-shaped system of electro-magnets, round which revolves a Gramme ring. The core of the armature consists of iron plates held together near their outer periphery by insulated bolts inserted parallel to the

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axis and prolonged to one side, where they are attached to a supporting ring, which, by means of arms and a central hub, is mounted on the spindle. The centre or yoke of the star magnet is bored out to let the spindle pass. The great advantage of this design is, that for a given sectional area of magnet cores and a given space available for the exciting coils, the weight of the field-magnets is reduced to a minimum, whilst the total length of magnetic circuit is also much shorter than in the usual design of dynamos with external magnets. There are, however, some practical disadvantages. The armature being overhung is more difficult to balance; it is more liable to injuries, and the active wire—which in this case is on the inside of the ring—cannot be so simply and securely fastened as in the usual type of armature. On the other hand, the output of internal-magnet machines is very great, as compared with their weight and speed. Thus, for instance, a 15-kilowatt machine, made by Mr. FEIN, weighs only 14½cwt., or 108lb. per 1,000 watts output. The speed in this case is 520 revolutions. Messrs. SIEMENS AND HALSKE have built during the year a fair number of internal-magnet machines, amongst which were four for 75 kilowatts output each, for the lighting of the Frankfort Railway Station. These are probably the slowest speed machines ever constructed; they are direct driven, each by its own vertical twin engine, at only 150 revolutions per minute.

The year 1887 has also seen a new application of dynamo machines for the conversion of high-tension continuous currents into low-tension continuous currents, or, to speak more correctly, the revival of an idea originally conceived by Gramme in 1874, and published by Niaudet a year later. The apparatus constructed by Gramme was a magneto machine, the armature of which was wound with two circuits, in the same way as that of the modern rotary transformer; but the primary object of the inventor was not the translation from a high to a low tension, but the reverse. He used Bunsen cells as a source of electricity, and by means of his apparatus obtained a higher electromotive force and a smaller current than corresponded to the battery, so that a few large cells could do the work of a great number of small ones. A reduction of the number of cells necessary to work over a telegraph line of high resistance seems to have been the principal aim for which Gramme devised his apparatus, and to all appearances he never foresaw the possible application of a rotary transformer for transmitting and distributing electrical energy over long distances. This application has been perceived by Edison, who during the last few years has taken out several patents for induction apparatus, whereby continuous high-tension currents can be translated into those of lower tension. In some of these designs the induction coils are stationary, and the commutating device only is in motion, worked by an electro motor, whilst in others the induction coils (arranged in the form of an armature) themselves are in motion. The latter arrangement, which in principle is identical with Gramme's original design, was taken up in England in the beginning of the year by Messrs. PARIS AND SCOTT, who actually showed a transformer at work at the close of the Newcastle Exhibition. As we have fully described this machine and the excellent results obtained with it in our issue of 28th October, 1887, we need not say more about it at present. In Germany, the question of continuous current transformers has been taken up by Messrs. JEHL AND RUPP, who have devised several types, some with stationary coils and a special distributing commutator, and others with compound wound armatures revolving in stationary fields. The fact that only one firm amongst the many English firms who build dynamos has taken an active interest in the matter of continuous current transformers seems to show that either there is no great prospect that there will be a want for such appliances in the near future, or that the practical difficulties in the construction and use of these transformers are greater than at first sight appears.

In the application of continuous currents for motive-power purposes, the year 1887 has left a fairly satisfactory record. Quite a number of electric railways and tramways were opened for traffic in America, and some of these of considerable extent. Electric locomotives of large size have been built by our trans-Atlantic cousins. As examples, we might cite the BENTLEY-KNIGHT locomotive and the FIELD locomotive. Details regarding the performance of the former have not yet reached us; but as regards the latter, trials recently made on the New York elevated railroad were exceedingly satisfactory. The locomotive weighs thirteen tons, of which nine tons go to the motor and four tons to the body of the vehicle and the regulating apparatus. In this engine the armature spindle is connected by side rods and cranks directly with the driving wheels, and develops an average of 40 to 50 horse-power. Recently storage batteries have also been introduced for working electric tramcars in America, and there is every indication that the present year will see a large extension of this system. On the Continent, which some years ago took the lead in matters connected with electric traction, little has been done during the past year, but in England good progress has been made. Of existing railways, those at Brighton and Portrush, the Bessbrook-Newry line, and the Ryde tramway have continued to work without a hitch. The difficulty experienced with the underground conductor on the Blackpool line has been successfully overcome by the employment of better insulators, and this line has now for some time again been in perfect working order. Of new enterprises in electric traction should be mentioned the Stratford and Manor Park tramway, where horses and Elieson's electric locomotives are used to draw alternate cars, and the Shoreham tramway, on which, during the summer, the cars of the Electric Traction Syndicate were run for experimental purposes. The Elieson locomotives have done plenty of hard work, and the fact that they could run in between the horse cars without disorganising the service shows that they are perfectly reliable. Neverthless, we look upon the Elieson system as essentially a pioneer system. Until tramway companies can be convinced that electric traction is not only as cheap or cheaper than horse traction, but also equally reliable, we cannot expect them to alter their rolling stock and to fit their cars with motors and batteries. They might, however, agree to attach their ordinary cars to electric locomotives, because this would always leave them free to revert to horse traction should the experiment prove a failure, and it is for this reason that we look upon Mr. ELIESON's locomotives as a pioneer system. But let it once be proved to the satisfaction of tramway directors that electric traction is cheap and reliable, then the separate locomotive must make room for the self-contained car, such as is used by JULIEN in Brussels, HUBER in Hamburg and Cologne, RECKENZAUN in Philadelphia, and the ELECTRIC TRACTION SYNDICATE in Shoreham. The application of motors for other than traction purposes has also made satisfactory progress during the year. The most perfect example of electric transmission of energy yet existing is probably the installation which the OERLIKON WORKS put up between Kriegstetten and Solothurn, Switzerland, in the beginning of the year. Recent trials have shown that the commercial efficiency of the whole plant averages 75 per cent., a result which, considering that the distance of transmission is five miles, surpasses anything yet accomplished in transmission of power. Coming nearer home, it is satisfactory to note that Messrs. IMMISCH AND CO., who have made a speciality of electro motors, have during the year

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been fairly busy with transmission-of-power plants, both for the home and colonial markets. Electric transmission of energy, although only over short distances, is also employed in Mr. F. J. ROWAN'S ingenious machine tools, which were exhibited at Newcastle. These tools are specially intended for use in ship yards, and are provided with powerful electro-magnets, by which they are firmly attached to the ship's side.

Our brief review of the year's progress in this branch of electrical industry would be incomplete were we to leave out all mention of the progress made in alternate-current machinery. In America, where the WESTINGHOUSE COMPANY have acquired the Gaulard-Gibbs patents, distribution by alternating currents is fast coming to the front. The company use a dynamo designed by their own electrician. It has a drum armature, containing an iron core, and is provided with Pacinotti teeth. The field consists of a circular yoke and magnet cores radiating inwards, and in this respect is similar to the alternate current machine made by Messrs. ELWELL-PARKER for the Eastbourne Central Station. But the armature is entirely different. By adopting Pacinotti teeth and saddle-shaped coils, each surrounding one of the teeth, the magnetic resistance of the Westinghouse machine is considerably reduced, whilst at the same time nearly the whole of the wire on the armature is active, there being no useless wire, such as the internal wire in a Gramme ring or the end connections in an ordinary drum armature. The machine should therefore have a large output for its weight, and in so far the design seems good. There is, however, the practical difficulty that the Pacinotti teeth are themselves liable to heating, and to cause heating of the pole-pieces. This defect in continuous-current machines has been almost entirely overcome by making the teeth very narrow, but for obvious reasons the same remedy cannot be applied in an alternate-current machine, and until some other remedy against heating by eddy currents is discovered we think that Pacinotti armatures will not prove satisfactory in such machines. The prevailing opinion, in England at any rate, is in favour of either a smooth core or an armature without any iron at all. In the two types of machines at present most widely used in England—viz., the Siemens and the Ferranti machine, the armature contains no iron, whilst a smooth core of coiled iron wire is employed in Messrs. ELWELL-PARKER'S machines. A large machine of this type has recently been delivered by this firm to the Brighton Central Electric Light Station, but as it has not yet been regularly set to work, we cannot say anything about its performance. The type is the same as that of the Eastbourne machine above mentioned, but the armature is of much larger diameter and proportionately very short. In order to avoid binding hoops the outside of the core has a considerable camber, so that the wire can be firmly wound on, and will not be lifted by centrifugal force. Alternate-current machines have during the year received attention from various quarters. The brothers HOPKINSON have got out a new type of dynamo for alternating currents, and a large machine of theirs is now completed; Mr. MORDEY has also been engaged for some time with a machine in which the field-magnets revolve and the armature is stationary, an excellent plan for insuring high insulation; and Mr. KAPP has brought out a new machine in which the armature is of the disc pattern, the core being composed partly of iron tape and partly of iron wire. The copper winding is secured by phosphor bronze castings inserted between adjacent armature coils. The field-magnet system is similar to that of ordinary multipolar disc dynamos. The advantage of disc armatures for alternate current machines is, that whilst the core can be smooth to prevent heating of pole-pieces, nearly the whole of the wire is actually under the influence of the field. This secures a large output for small weight, and the first machine made by Mr. KAPP, and which we saw tried in the early part of last autumn, gave an output of one kilowatt for every 100lb. dead weight. Another, but much larger machine, is now in course of construction. It is intended for an output of 40 kilowatts, and has cast-iron field-magnets, this material having been chosen to reduce the labour which would otherwise be required in fitting a large number of wrought-iron magnet cores into cast-iron yokes.

In transformers for alternating currents the year 1887 has brought several novelties. Leaving aside the transformers of the Ferranti and Hall type, which properly belong to the previous years, there were brought out last year the following transformers, amongst others:—One by WESTINGHOUSE, in which the primary and secondary are wound upon each other, and the core is afterwards inserted in the shape of rectangular frames of thin sheet iron, having a central webb. The webb is connected with the frame on one side only, so that it can be bent up, allowing the frame to be slipped over the coils, and when in position the webb is bent back again into the plane of the frame. These transformers are placed in watertight iron boxes and are generally fixed out of doors on the poles which carry the primary and secondary circuits. Another transformer has been devised by Mr. MORDEY. The outer portion of the core consists, as in the Westinghouse transformer, of a rectangular frame, and the portion stamped out from the middle is laid across to form the central webb, so utilising all the metal. In this case the length of the outer edges of the rectangle must obviously be in the proportion of 2 to 3. Mr. KAPP has brought out a transformer, the core of which consists of U-shaped stampings laid together to form a double trough. The coils are separately wound, and after being placed into the troughs the latter are closed by covers made from the metal which was stamped out of the U-pieces. Messrs. GAULARD AND GIBBS also use U-stampings, but place them in a circle, thus forming a kind of Zipernowsky transformer; but with this difference, that instead of employing a core of iron wire wound over the coils in an irregular manner, and thereby rendering access impossible, the core is neatly arranged and removable for examination and repair of the coils.

Taking it altogether, the record of heavy electrical engineering during the past year is fairly satisfactory. If central station lighting has not progressed with us at the same rate as is the case in America and on the Continent, some good work has been done in other directions; and with all their improved machines and appliances electrical engineers can now feel confident that, if the call for "more light" from central stations comes—as come it surely must—they will be in a position to supply the wants of the public without risk of failure.

Electric Lighting of Trains in Canada.—Electric lighting of trains is receiving attention in Canada. The first train in the Dominion to be so lighted is regularly running between Montreal and Ottawa. A Pullman drawing room car, one first-class and one second-class, are fitted with incandescent lamps and Julien storage batteries. There are nineteen lamps in each of the two former cars, and thirteen in the latter. When arrangements are completed, trains will run from Halifax and St. John to Quebec and Montreal, lighted by electricity and heated by steam. It is reported that the Canadian Government has appropriated for electric lighting and steam heating on the Inter-Colonial the sum of $24,500, and that road is actively at work equipping two trains with Julien storage batteries.

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LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

(*Continued from page 180.*)

CHAPTER VI.—*Current Indicators.*

54. The laws of the current, and the relation between E.M.F., resistance and current having been considered, we shall now examine some of the instruments used to indicate the presence of a current, these being termed *detectors* or *indicators* in distinction from galvanometers or current measurers. It will also be shown how detectors may be calibrated so that their indications may be made to show the exact strengths of current passing through them.

55. Detectors are in constant use on land-line telegraph circuits, one being fitted to each Morse instrument, so that when the operator is sending a message he may observe that his current is going out to line all right. And when the distant station calls up the call is shown on the detector as well as the Morse armature, so that if the latter should fail for any reason there will still be always a visual indication attracting the attention of the operator.

Detectors are very useful in tracing a fault on an instrument or line or in identifying certain wires from a large number. The manner of doing these will be explained as soon as the instrument itself has been considered.

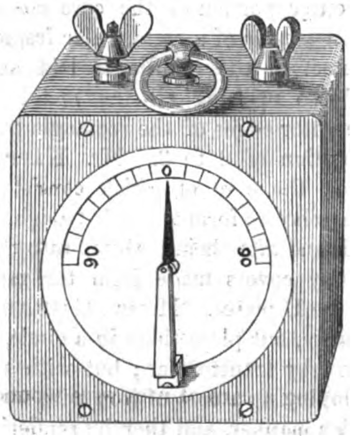

FIG. 18.

56. One of the most useful and common forms is shown in Fig. 18, which will indicate the *direction* of a current by the needle being deflected one side or the other. It is advisable to ascertain which way the needle moves with a given direction of current through it, as we shall require to know this frequently when testing with the instrument. Suppose that on connecting it to a voltaic cell, as in Fig. 19, the needle moved to

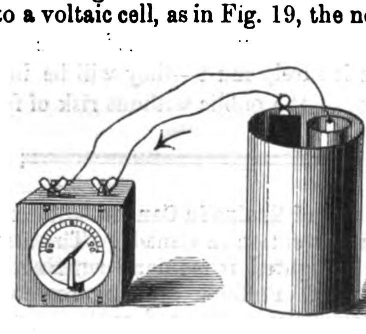

FIG. 19.

the right, then knowing that the current leaves the carbon plate in the cell and enters the detector by its right hand terminal, as shown by the arrow, we should know that the needle would always deflect towards the terminal where the current entered or towards the positive terminal. For if we reversed the wires on the detector, so that the current entered by the left-hand terminal, the needle also would be deflected to the left.

57. All instruments do not deflect the same way for the same direction of current through them. The direction in which the needle of an instrument will deflect when a given current is supplied to it depends on three things:—

1. The position of the poles of the needle relatively to the coil when the former is at rest.
2. The direction of winding of the instrument coils.
3. The connecting up of these coils to the instrument terminals.

As an illustration, we might cause the deflection of the above detector in Fig. 19 to be always towards the *negative* terminal by altering *either* of the three conditions mentioned. But if we altered the instrument by any two of these conditions, say the position of the needle at rest, and the connecting up of the coils to the terminals, we should not alter the direction of deflection for a given current, since these two changes would neutralise each other. Similarly, if we altered all three conditions, we should *reverse* the deflection.

58. There are two needles to the instrument, one, the smaller, N S, being of hard steel well magnetised and

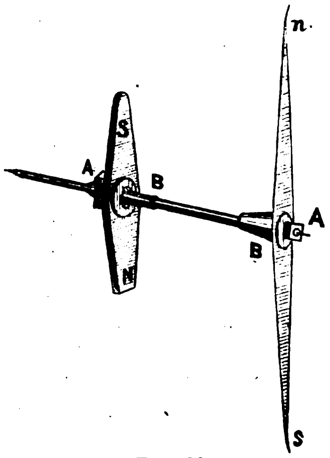

FIG. 20.

weighted at the end N, this end being made broader. The use of this is to bring the needles back to zero again after being deflected, or, in other words, to act as a controlling force (viz., that of gravity on the larger end) to the system. Fig. 20 shows the needles and spindle detached from the instrument. The longer needle *n s* which is seen outside in Fig. 18 has its poles reversed to those of the inner

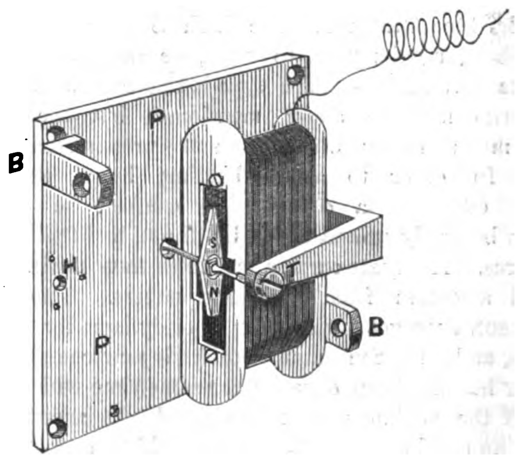

FIG. 21.

needle N S. The reason of this will be explained with the action of the coil.

Both needles should be perfectly parallel, to ensure which each is pierced with a square hole at its centre, which fits over a square key on the brass hubs B B; and the latter having a very fine thread cut permits of tightening up the needles securely in position by a little square-headed nut

(shown at A A), which can be screwed on by means of a small pair of pliers.

Turning now to the interior of the instrument the two coils are wound on brass bobbins, one of which is shown mounted in position in Fig. 21, the other having been removed to expose the needle, N S, to view. The mounting of the spindle can also be seen, and the freedom of the latter to turn can be adjusted to great delicacy by the screw, T. The interior space of the coils in which the needle moves is very little larger than the needle itself; which brings as much turning force as possible to bear on the needle when the current is on; this makes it important to fix the coils accurately in position, so that the needle may not touch the sides during any part of its play. The brass bobbins are therefore screwed on to the brass plate P with little brass pins to act as guides and keep them in position. The screw hole of the removed coil is seen at H and the three guide holes round it. The brass angle pieces B B serve to screw the plate and coils when adjusted inside the wooden box of the instrument.

Regarding the winding of the coils, it should be remembered that the current must flow through both coils in the same direction, since the two coils should form virtually one electro-magnet; in fact, the reason for the electro-magnet being made in two coils is only for facility of construction and getting at the needle conveniently. In order to be able to detach each coil separately from the instrument (for convenience of adjustment) the coils are not connected by a wire between them, but the underneath end of each coil is soldered on to the brass bobbin. So that before starting to wind a coil the end of the wire is soldered to the brass bobbin, and when the coils are finished and screwed into their places electrical contact is made between the two *inside* ends of the coils through the brass work.

(To be continued.)

THE USE OF ACCUMULATORS FOR TELEGRAPHY BY THE EXCHANGE TELEGRAPH COMPANY.

BY MR. F. HIGGINS.

During the past six months the Stock Exchange tapes have been worked from the Cornhill office by means of accumulators, which have replaced 2,000 of the batteries formerly in use. These accumulators are grouped in three sets of seventy in series, and are of the 7 L size, contained in glass cells.

As a result of our experiments to ascertain the best conditions for the employment of accumulators in this work the following arrangements have been adopted :—

The plates are placed double the usual distance apart, in order to reduce polarisation, internal leakage, and contacts due to particles of scale, &c. The glass cells have an extra depth, making them 5in. above the tops of the plates, to admit of the employment of spray interceptors of glass, on the principle pointed out in a communication to the Society of Telegraph-Engineers and Electricians in March, 1886, to preserve the insulation, and restrain the acid from entering the air and corroding the connections and surrounding machinery.

An important economy of motive power is obtained by increasing the distance apart of the plates. Those which are only ⅛th of an inch apart take 10 minutes longer per day to charge up to the gas-producing point, with the current at 15 amperes, than do similar 7 L size plates at ¼in. apart, and the motive power thus saved amounts to 14 horse-power-hours per week. The state of affairs inside can also be readily examined; should scaling take place the flakes can get to the bottom of the cell without hindrance, and the reduction of polarisation, due to the increased volume of acid between the plates, contributes materially to the steadiness of the current.

The following observations of the charging and discharging current were made, a portion of the discharge, which is intermittent, being caused to pass through a copper voltameter for this purpose :—

The potential of the dynamo was 194·15 volts, that of seventy accumulators while enveloped in nascent gas as nearly as possible at their highest 154·46 volts, the resistance of the external circuit of seventy cells being 1·236 ohms, and that of the dynamo armature 1·254. The available potential with this resistance should cause a flow of 15·9 amperes; but the observed current was between 15 and 16 amperes. The slight difference may be due to the less perfect contact of the brushes when in motion, and also to the slight increase of temperature in the armature. The charging current was equal to about 25·35 horse-power-hours, and the discharge as measured by the decomposition effected was equal to 88·128 ampere-hours at a potential of 154·46 volts, or about 18·24 E.H.P.

The useful return appears, therefore, to be about 72 per cent.; but if the difference of potential between the charging and discharging current be deducted, the loss in the battery itself appears to be only 7·7 per cent., some part of the latter being purposely wasted in overcharging.

A peculiar phenomenon was noticed in connection with these batteries which caused the repeated failure of the india rubber bands, and was a source of inconvenience at the commencement of their use; but a study of the effects and the discovery of the cause enabled us to provide a remedy which is perfectly effectual in protecting bands which would otherwise not stand for 48 hours.

It was found that when imperfectly cured india rubber is placed near to or in contact with the negative element of an accumulator, oxidation, and consequent loss of elasticity, takes place opposite the positive plate. The same oxidation occurs under similar circumstances with some other inflammable hydrocarbons, but not with well vulcanised india rubber, which is not so combustible or readily oxidised as pure or slightly vulcanised india rubber. Insulation by means of glass plates on *every* side is a perfect protection to the bands, not one of which has failed since having been so provided.

No sign whatever of buckling or flaking has yet appeared, and we do not anticipate working under the conditions which are necessary for their production. A most successful method to produce buckling experimentally is to associate cells of different capacities or different charges in series, and exhaust, or nearly exhaust, the larger. This, if repeated a few times, will not only cause the plates to buckle, but to shed their plugs in showers.

It is sometimes impossible to avoid the occurrence of these unfavourable circumstances in the case of cells which are leaking internally, but if the plates be placed further apart than usual, and the cells kept dry outside by spray arresters, and regularly charged, they may perhaps be reduced to a minimum. Slight buckling can also be produced by discharging too rapidly, but no damage, as far as my experiments have gone, results from repeatedly charging and completely discharging cells.

The crippling of plates by their own weight may be avoided by suspending them from above; as at present arranged a great responsibility rests upon the tenderest part.

The current obtained from these batteries for working our type-printing apparatus is steadier than from the primary batteries previously employed, and shows no perceptible variation from day to day. But they are not suitable on account of their size for small offices, which would require less than 1,000 cells of primary batteries, because accumulators to furnish the maximum working potential of 300 volts would occupy a space greater than would be required for the primary batteries, and entail about the same attention in charging.

The greatest volume of current employed at one time for this service is 35 amperes, and the time necessary for charging may be calculated from the number of words transmitted to within a few minutes daily.

Electric Burglar Alarms.—The *Western Electrician* mentions that "the New York police calculate that if burglar alarms were not in such general use in that city it would be necessary to employ fully twice as many patrol men to prevent burglaries. They declare that these automatic alarms are of the greatest use in preventing crime or making it ineffective.

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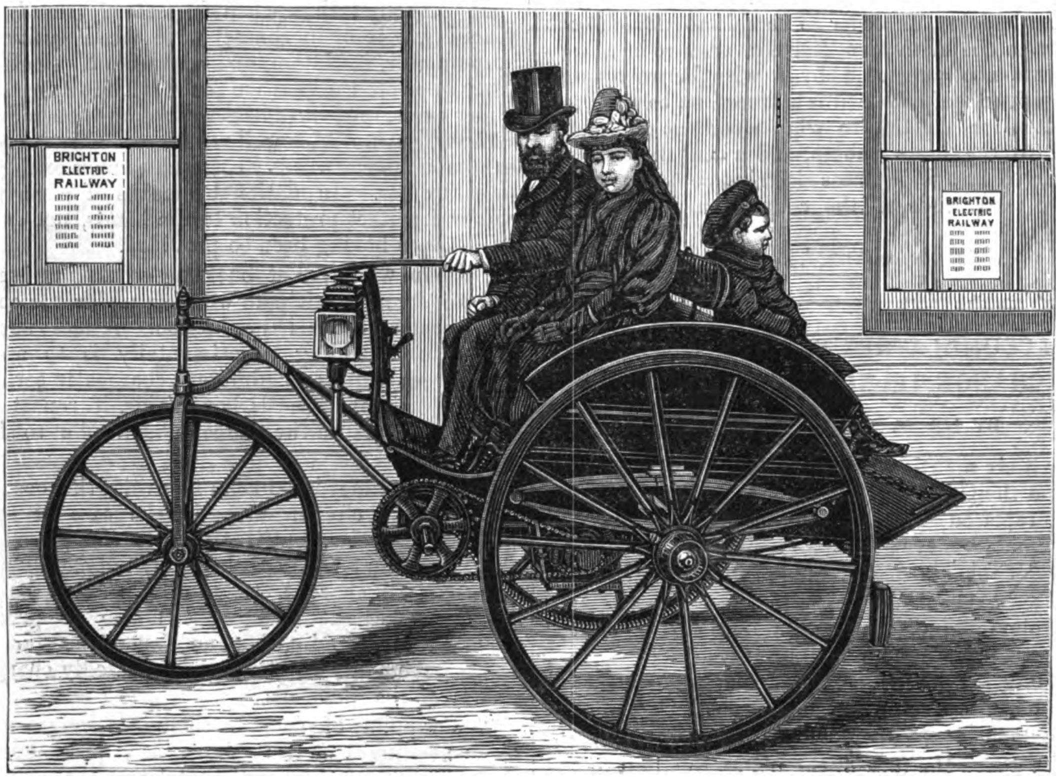
VOLK'S ELECTRIC DOG-CART FOR ORDINARY ROADS.

Mr. Magnus Volk, of the Brighton Electric Railway, has recently turned his attention to the application of electric traction to vehicles running upon ordinary roads. The dog-cart represented in the adjoining engraving was built by Messrs. Pack, coach-builders, of Brighton, and is driven by an Immisch motor of ½ horse-power type. The current is supplied by 16 E.P.S. accumulators, which at the normal rate of discharge are good for a six hours' run. The cells are placed under the seats. The motor is supported by hangers under the body of the car, and drives on to a counter-shaft in front by a Renold's steel link chain. Upon the inner side of the rim of the right-hand wheel, which is 4ft. in diameter, are a number of blocks fixed about 1ft. apart, and a second steel chain passes from the counter-shaft around these blocks. The arrangement is neat in appearance, and has the advantage of reducing the weight of the gear to a minimum.

The motor at present employed weighs 40lb., though it is scarcely large enough for the work it has to do. The experiments so far made have resulted in obtaining valuable data as to the tractive force required for vehicles on roads of various kinds. On asphalte the tractive force is less than on a grooved rail, and a speed of nine miles an hour can be obtained, whereas on a soft macadam road only four miles an hour is possible. With a load of two persons a grade of 1 in 30 can be surmounted.

The vehicle is the object of much attention just now in Brighton, and taken altogether as a first experiment the results may be considered to be interesting and satisfactory.



VOLK'S ELECTRIC DOG CART.

ELECTRIC LIGHTING EXPERIENCES IN INDIA.

BY L. A. DAVIES.

Some of the readers of *The Electrician* may have heard of he big steel girder bridge erected by the Oudh and Rohilkund Railway Company over the Ganges, at Benares, and opened last month by the Viceroy, and now known as the "Dufferin Bridge."

Nearly all the rivers of India are subject to heavy spates during the monsoon, which put a complete stop to all work in the river-bed for some four or five months in the year, and thus render it necessary to take advantage of every hour of low water. The Oudh and Rohilkund Railway Company accordingly purchased a plant of electric lamps and dynamo, to enable them to carry on the construction of their great bridge by night, and I was sent out to fix and work the lights.

The piers were being built and sunk when I reached Benares. These are of brickwork, and of great size. Everybody concerned was positive that it would be quite impossible to do brickwork of the high standard usual in Indian railway works by any artificial light, and as to working the 20-ton cranes and big diggers, it would be folly. The drivers, coolies, &c., would tumble off the staging, and all sorts of accidents would happen. However, as the lamps were there, and had been paid for, I was allowed to hang them up, with the result that work went on as merrily by night as by day, to the great astonishment of the natives and the satisfaction of all.

We had a rather neat way of hanging the lamps for pier-building. There was nothing extraneous whereon to hang them, the piers being simply *growing* red brick islands in the river bed, so I got made some bamboo tripods sufficiently high, and hung the lamps from a shackle on the iron bolt connecting the three legs. When the bricklayers worked up to the tripods my coolie in charge shifted them on to the new course, and so bricklayers, coolie, tripods, and all rose in the air together.

When the time came for erecting the girders the old fears were expressed that it would not be safe to lift such heavy weights by artificial light, and the English riveting foreman vowed they would not be able to see whether their rivets were properly heated or not; however, as before, a trial showed the unreality of the difficulties raised, and erecting and riveting proceeded, like the building and sinking, night and day. The resident engineer, Mr. Granville Walton, was quite alive to the need of making the most of the low-water season, and used the light wherever possible, with the result that every operation went on by its means. Lamps were hung from the corners and centres of the lofty gantries which carried the hydraulic riveters, and from the Goliath cranes, all being connected to the mains by loose insulated wires, thus in no way interfering with the necessary movements.

The plant used was of the Gülcher type, which necessitated the use of a parallel system of connection. The wiring was

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thus rather complicated, especially as none of the lamps were often in the same place for two nights together. Short circuits were of pretty frequent occurrence, nothing but bare wire having been sent out originally; but a simple system of methodical disconnection soon made the men expert at localising the fault even at night, and I made a practice of testing for insulation each main, with all lamp switches open before starting. I set off against all this the freedom of anxiety as to nasty shocks obtained by using a low E.M.F., and the sufficiency of slight insulation. Whilst employed at Benares I went up to the other end of the Oudh and Rohilkund Railway Company's line to put down an installation of two Brush dynamos and twenty-six lamps to be used in the construction of another bridge over the Ganges at Balawali, nearer its source, and I was always very much afraid that some careless native would hurt himself in spite of the well-insulated cable used. The simplicity of construction peculiar to the Gülcher lamp renders it very suitable for use with native assistants, as they soon learn to clean and recarbon it, and even to adjust it. The Gülcher dynamo sent to Benares was of a rather ancient pattern, and though electrically very efficient, was not so satisfactory from a mechanical point of view. It was awkward to open up, and still more awkward to put together. The wires connecting the armature and commutator ran through a hollow bearing, coming out in a bunch before spreading to the commutator, and this bunch was a sort of half way meeting place for lubricant from the bearing and copper dust from the commutator. There were also two unncessary brushes. I got a pedestal cast, and a new spindle turned, so as to get a bearing outside the commutator, and connected up the armature sections so as to do away with the two extra brushes. However, I find that all these improvements, and others equally important, have been effected in the machines as now made by the Gülcher Company.

Four Siemens differential lamps, with water-tight cases, and two small Siemens dynamos had also been supplied to the bridge works for diving purposes. We tried to make use of these when divers were at work cutting into the clay bed in the pier wells; but the muddy state of the water rendered them quite useless. I stripped and took a plunge into one of the wells myself to see what amount of light one of these lamps was giving under water, and found that a yard from the lens the arc looked about as bright as a lighted cigar end on a foggy night.

The whole installation, however, was such a success that five more lamps were ordered to make up the full complement of the machine, and also fifty incandescent lamps of the Swan-Edison type, and I myself was kept in the service of the company for four years, instead of the six months for which I was originally engaged.

I would advise any brother electrician going out to a distant country to thoroughly inspect the apparatus he is going to use before starting. I, unfortunately, had not the opportunity of doing this, everything having been sent off round the Cape in a sailing vessel before I was engaged, the consequence being that I was put to innumerable shifts and dodges to supply deficiencies. Nothing at all had been sent in the way of resistances for the lamp circuits. Not an instrument of any description, not even a speed counter. Of course, when I arrived there and discovered this, I indented for everything needful, but in the meantime had to rub along by hook and crook. I will just mention here that dynamos and lamps should be fitted with vulcanised fibre insulating washers and brushes when intended for India, as ebonite seems to crack and perish in so hot a climate.

Hindoos and Indian Musselmans are very good sort of people to work with. They are fairly quick and tractable, and soon pick up as much as is necessary for them to know. At first, of course, I had to do everything myself both day and night, but by degrees I got a good crowd of men together—some, of course, better than others—and was enabled to take matters more easily. The native idea of electricity was very amusing. I have often seen an intelligent Babu take up gingerly the end of a wire to look for the hole through which the "howa" travelled. "Howa" means air, but is also the name given to steam, and they (the natives) firmly believed that the steam in the boiler passed along the wires and caused the lamps to burn after having been rendered invisible in the "masine." "Howa" it began and remained, according to them. Some few, however, called it "bijli," or lightning. A good deal of valuable awe attached to me as the sahib who controlled and had in subjection this mysterious force and its appliances, and a dimmer halo surrounded the heads of my men in the eyes of their countrymen. Coming into the machine room at night I would often find the little Mahommedan lad, Ghazi, who had charge of the dynamo bearings and brushes, the centre of a crowd of wealthy Mahajans and Babus from the city, who would be humbly questioning him as to the wonderful properties of the machine, and he arrogantly giving some fearful theory of his own as gospel and pocketing annas for magnetising their knives on the magnet poles.

KENNEDY'S SINGLE-MAGNET DYNAMO.

We illustrate herewith two types of machine, recently introduced by Mr. Rankin Kennedy, of the Woodside Electric Works, Glasgow, in each of which the field is wound with a single coil. In the machine shown in Fig. 1 the field-magnet

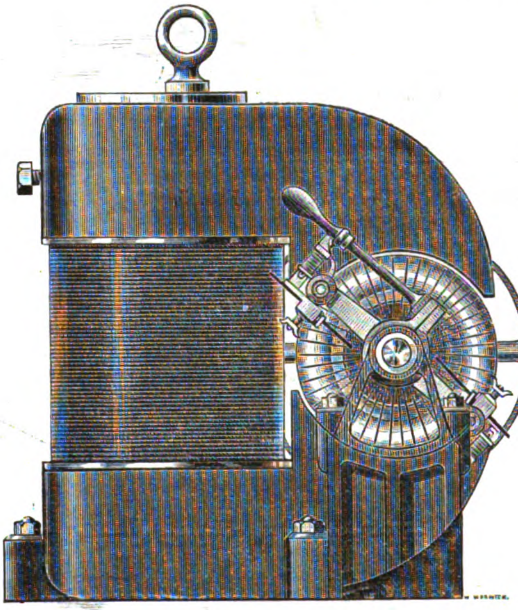

FIG. 1.

is made of three pieces, with only one field bobbin. The core of the bobbin is made of hammered scrap iron, and measures 10in. in diameter and 14in. in length; the pole-pieces are of soft cast iron, and are of much greater cross section than the core of the bobbin. This construction has the advantage of simplicity, combined with compactness and low magnetic resistance. The armature is built of charcoal iron discs, and the core is turned true, outside and inside, and mounted on metal spokes on a steel shaft; the outsides of the armature are usually turned up true on the shaft. The armature core of this machine is 12in. long, 10in. in diameter outside, and 6in. inside diameter, the depth of core being thus 2in.; the armature is wound with flat wire 5mm. by 3·5mm., one layer outside. The current allowed for this armature running constantly for long runs is 90 amperes. The commutator is made of solid-drawn copper sections, insulated with mica, and is of large size. The brushes are adjustable in all directions, and the pressure on the commutator is adjusted by springs. The brushes require a slight adjustment for varying loads, but at a speed of about 900 revolutions this machine gives 102 volts at the terminals.

On next page is a copy of a report furnished by Prof. Jamieson of a ten-unit dynamo of this type.

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Report on Rankin Kennedy's Single Horseshoe Magnet Dynamo.

I tested this dynamo on Friday, the 4th November, 1887, and had it run continuously for eight hours at full load (with the exception of about half an hour during the workmen's meal hour).

The dynamo, which is a self-regulating, compound-wound machine, consists of a single horseshoe magnet, with an armature of the Gramme type. The core of the magnet is made of soft hammered scrap iron, the pole-piece of hematite cast iron, and the armature core of soft charcoal iron washers.

The whole machine is exceedingly simple, strong, well-proportioned, and well put together. It is just the kind of dynamo for factories, mills, workshops, and steamers, for it may be left in charge of any ordinary mechanic or fireman, with a minimum chance of its getting out of order.

All the adjustable parts are readily accessible, and the armature may be removed and replaced in as short a time and with less trouble than almost any form of dynamo that I have seen. There is no perceptible sparking at the brushes. The commutator and the brushes, both from their construction and composition, as well as the freedom with which the latter can be adjusted, are calculated to last for a very long time. None of the parts of the dynamo showed any signs of undue heating, and the ventilation of the armature was all that could be desired.

From a sample of my electrical tests it will be observed that the dynamo gave an "output" of 10,850 watts or 108·5 amperes, and 100 volts at 620 revolutions per minute, and that the electrical efficiency was 89·3 per cent.; which is good for a dynamo expressly designed as a cheap, practical, workshop or factory machine, and not as a special test dynamo for experimental purposes.

With due attention to the oiling of the bearings, &c., there is no reason why this machine should not work continuously for a week or more on end, without giving the least trouble; and if the future machines made by the same firm are as carefully designed and constructed as the one I had the pleasure of testing, they should give satisfaction to the purchaser. It is a distinct improvement on their former dynamos. (Signed)

Andrew Jamieson, M.Inst.C.E.

Sample of Electrical Tests.

Resistance of armature, warm,	= ·04 ohm.
Resistance of magnet shunt, warm,	= 20 ohms.
Resistance of magnet main coil, warm,	= ·03ohm.
Current in working circuit	= 108·5 amperes.
Current in shunt magnet coils	= 5 amperes.
Difference of potential at dynamo terminal	= 100 volts.
Difference of potential at brushes	= 103 volts.
Speed in revolutions per minute	= 620
Temperature of air	= 60° F.
Highest temperature of armature	= 140° F.
Highest temperature of magnet coils	= 125° F.

Electrical Efficiencies.

External electrical power, or "output," available for electric lighting, &c.—

$= C \times E = 108·5\ A \times 100\ V = 10{,}850\ \text{watts} = 89·3\%$

Power absorbed by armature—

$= C_a^2 \times R_a = (103·5)^2 A \times ·04\ \omega = 428·49\ \text{watts} = 3·53\%$

Power absorbed by shunt magnet coils—

$= C_s \times E_s = 5A \times 103V = 515·0\ \text{watts} = 4·24\%$

Power absorbed by main magnet coils—

$= C_m^2 \times R_m = (108·5)^2 A \times ·03\ \omega = 353·17\ \text{watts} = 2·91\%$

Total electrical power—

$(C \times E) + (C_a^2 \times R_a) + (C_s \times E_s) + (C_m^2 \times R_m) = 12{,}146·66\ \text{watts.}$

(Signed) Andrew Jamieson.

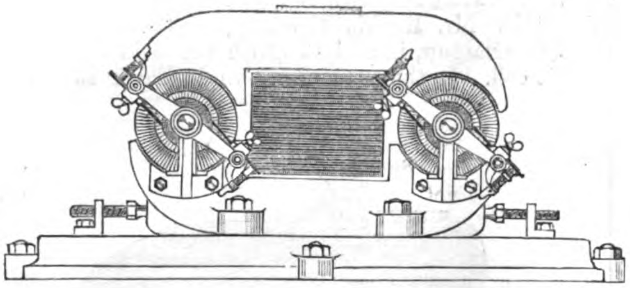

Fig. 3.

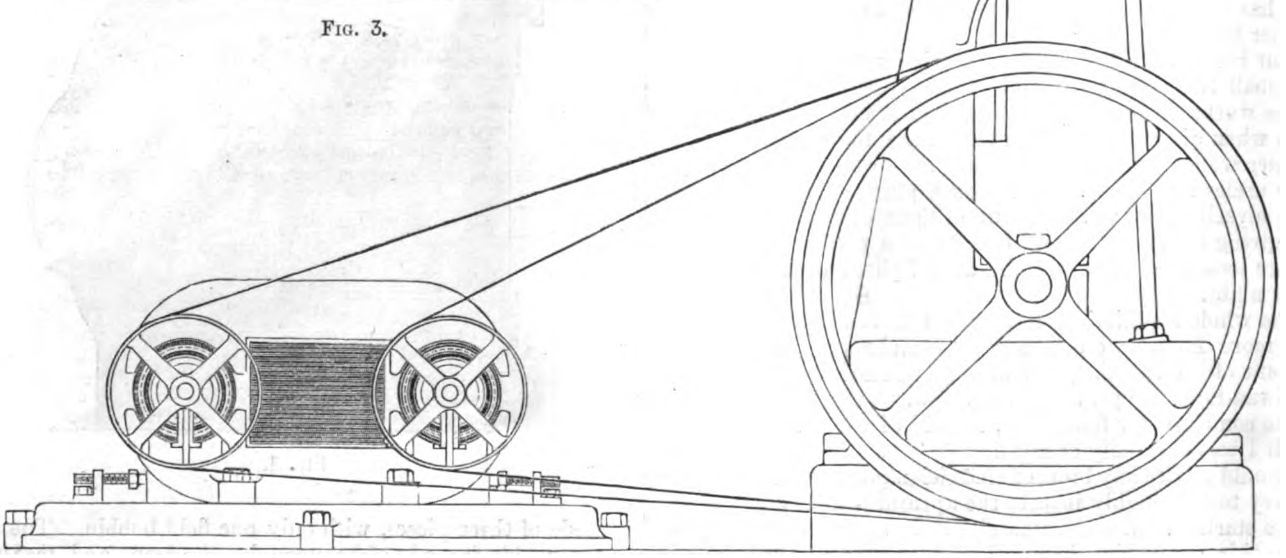

Fig. 2

The peripheral speed of the armature of this machine is only 1,900ft. per minute.

The machine illustrated in Fig. 2 possesses two distinct armatures with one field-magnet. The two armatures may be run together, if desired; but in introducing this machine the makers had more particularly in view to meet the requirement of a spare dynamo at low cost. Their views on this subject are stated as follows:—

"In a ship where space is scarce two dynamos are not often admissible, and a spare armature is invariably carried. Now, this new dynamo is really two complete dynamos in one machine, and the space occupied by the double machine is not more than that taken up by one machine of the best type, and the cost is at least 30 per cent. less than the cost of two machines, being just about equal to one machine and a spare armature. One half of the machine is able to do the whole work, so that repairs may be made on one half of the machine while the other half goes on with the lighting. By adopting a double dynamo

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all risks of loss of lights through accidents to the running machine are entirely obviated; of course, a spare armature meets the case, but here we have the spare armature in place ready for operation at a moment's notice."

Fig. 3 represents another type of machine with double armature.

IRISH'S ELECTRIC TRAMWAY SYSTEM.

A novel method of conveying current to the trailing collector of an electric tramcar has recently been introduced by Mr. W. E. Irish, of Cleveland, U.S., and seems to obviate some of the most serious objections which have hitherto prohibited the employment of conduit systems upon city lines in this country. It still remains to be seen whether or not the device entails other practical difficulties of an equally serious character; on this point we for the present offer no opinion. Mr. Irish proposes to lay along the centre of the track a third rail consisting of short sections insulated from one another and from the earth. These sections rest upon and are supported by a continuous length of india rubber tubing of oblong or elliptical section, and entirely closed throughout its whole length. Within this tube are a series of flanged contact pieces of copper of T section, the same in number as the sections of the rails. Each contact piece is secured by screws passing through the india rubber to the section of the rail above, so as to secure good electrical connection. At the bottom of the tube the conductor itself is laid, and under normal conditions it is separated from the stem of the T piece by a short space. The trailing wheel of the car is, however, caused to bear upon the upper rail with sufficient pressure to compress the india rubber and to bring the contact piece against the conductor, while as soon as the wheel leaves this section of the rail the elasticity of the rubber again breaks circuit at this point.

The diagram in Fig. 1 will show the arrangement of the parts more clearly.

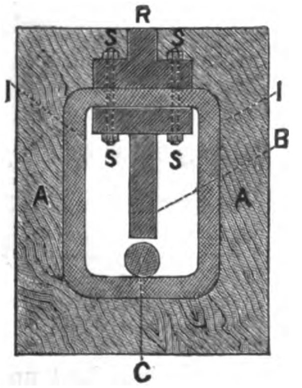

Fig. 1.

A A, Stone or Timber Channel; I I, Section of India Rubber Tube; C, Conductor; B, Contact Piece; R, Rail; S S, Screws connecting Contact Piece with Rail and passing through India Rubber Tubes.

Mr. Irish prefers to use two of these conduits side by side for the positive and negative conductors. He also employs a rotary brush, with stiff wire fibres running in front of the contact wheel, to clear the dirt from the rail.

It will be seen that this arrangement affords perfect security to the conductor, which is completely enclosed along its entire length. The sections of the central rail are also laid flush with the roadway, so that its presence offers no additional obstruction, and from this point of view would appear to be entirely unobjectionable. The danger of short-circuiting by the passage of ordinary traffic over the line is not, however, entirely obviated; in fact, it appears to be somewhat greater in this system than with a slotted conduit. Any heavy vehicle standing across both positive and negative conduits would bring those sections into the circuit; but it is perhaps improbable even than that metallic connection would be established.

The equipment of the car does not, so far as our information extends, present any novel points of special value, though it seems to be of a thoroughly practical and workmanlike description.

AN INDIA RUBBER COMPENSATOR FOR TELEGRAPH, TELEPHONE, SIGNAL, AND OTHER WIRES.

BY R. BOZON.

The severity of the weather this time last year turned my attention to the problem of counteracting its effects upon overland telegraph and telephone wires. My first idea was of a very similar character to that already described in the columns of *The Electrician* by Mr. Caws, of Sunderland, though I was at that time unaware of his experiments. I first employed a steel spring, let into the length of wire, and found that this greatly raised the breaking strain of the combination. It soon struck me, however, that it would be necessary to afford protection from the weather, and I therefore enclosed the spring in a thin brass telescopic case, in which the spring acted upon a piston and rod, fixed to the outer case, and was effectually protected from the weather. The telescopic case, however, considerably increased the weight of the appliance. In order to reduce the weight and cost, I found that the only thing to be done was to make a single case, and to allow the piston rod attached to the spring to pass through a well packed stuffing-box at the end of the case. Even this, however, did not sufficiently reduce either the weight or the cost, and I therefore came to the conclusion that this did not constitute a practical arrangement.

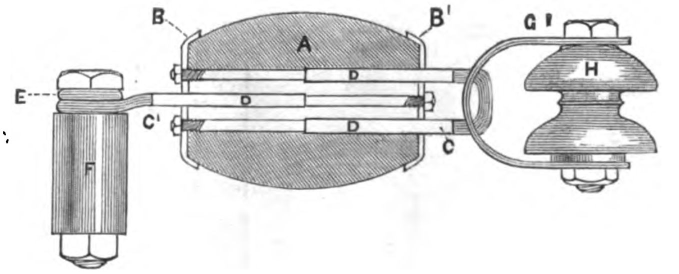

Fig. 1.

A the india rubber cushion between the compressors B and B′, which are maintained in their relative positions by forks C and C′, which are encased where they rub by pieces of brass tube D D D to prevent rusting. E is the loop at the end of fork C′, to enable it to be bolted to part of post F. G the steel band on the end of fork C shackles the insulator H, which is connected to the line.

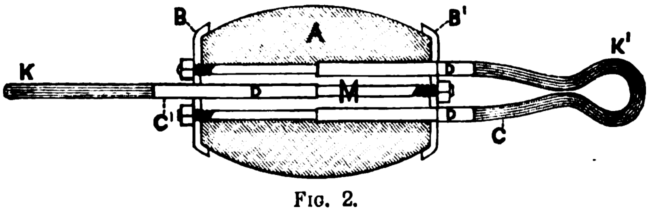

Fig. 2.

This acts exactly the same as Fig. 1, the difference being at the terminals K and K′, which are intended to be joined to the wires, and the currents to pass through the compensators. If the contact is not sufficient, I propose a collector to be attached at M.

Not being willing as yet to allow myself to be baffled, I continued to experiment, and before long was led to try india rubber, and this substance answered beyond my expectation. The form of the india rubber compensator which I finally adopted for telegraph wires is represented in the sectional drawing, Fig. 1, which is sufficiently explained by reference to the lettering.

The elasticity of the india rubber between the compressors B and B′ holds the compressor B′ stationary, while the other compressor B is always more or less in a state of vibration as the stress on the line varies.

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The pattern designed for use with signal wires is similar to Fig. 2. One of the advantages of this arrangement in telpherage is that it can be applied to any length of line without making a joint; in fact, it is only necessary to remove the shackle, the insulator being left on the line until the compensator is bolted to the post, when the same insulator can be shackled to the other end.

I have found by experiment that with an india rubber cushion, measuring 4in. in length and 3in. in diameter at the widest part, the contraction under pressure reduced the length as follows:—

Pressure.	Length in inches.
0	4
½ cwt.	3¾
1 "	3½
1½ "	3¼
2 "	3
2½ "	2¾

This table could be altered, as found by experiment to be of the greatest advantage, by altering either the quality or thickness of the india rubber.

PATERSON AND COOPER'S AMMETERS AND VOLTMETERS.

I.—Permanent Magnet Instruments.

Permanent magnet instruments have this advantage over many other types of ammeters and voltmeters that they are very dead-beat, and although possessing the defect that they are liable to alteration through the magnet being weakened or strengthened, they are favourite instruments, the demand for them still keeping up. When working with accumulators they are specially serviceable as indicating the *direction* as well as amount of current. These instruments, the original design of which was due to Profs. Ayrton and Perry, have been greatly improved by the makers during the last two years, the interior of the present pattern being shown in Fig. 1. Formerly the different parts of the instruments were independently fastened to the ebonite slab; now all the various parts which must be preserved in the same position relatively to each other are mounted on a strong metal plate, the shape of which is in no way altered by any possible shrinking of the ebonite. The magnet is of horseshoe shape, of steel, with soft iron pole-pieces. The needle is of soft iron, elliptically shaped, and mounted in the coil frame, the pivots moving in jewelled holes. When the instrument is wound the needle is almost completely enclosed by the coil The coil frame with the needle is attached to a bar, which can be moved parallel to the axis of the needle, this adjustment being employed to obtain the proper value for the deflections. As the needle is pushed into the field the value of the deflections increases, reaching its maximum when the axis of the needle lies on a line joining the centres of the poles; withdrawing the needle decreases the value, and the adjustment is made until the instrument is direct-reading. The coil frame is itself capable of movement round the staff of the needle as a centre, the object of this adjustment being to get the magnetic axis of the coil exactly at right angles to the magnetic axis of the magnet, and as a consequence the deflections right and left equal. Besides these two adjustments there is one more to be mentioned. Screwed through each of the soft iron pole-pieces, and slightly protruding towards the needle, is a soft iron pin, by moving which the distribution of the field lines is modified, until the deflections for the whole of the scale are proportional to the current flowing round the coil. These several adjustments are made by the makers, the instruments having, when sent out, a straight line law and reading direct. The ammeters and voltmeters are essentially similar in construction—the winding only being different—and in the voltmeter the terminals smaller. The voltmeters are provided with a spring push to be pressed down when readings are being taken.

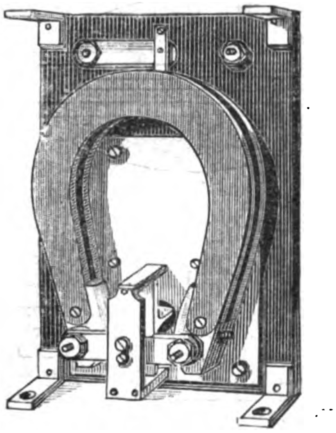

Fig. 1.

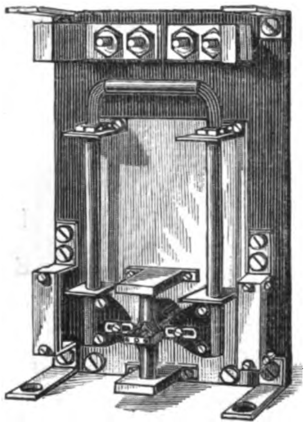

Fig. 2

II.—Electro-magnet Instruments.

For the reason above given that the permanent magnet instrument is liable to error from the strength of the magnet altering, the electro-magnet instrument was introduced, the current to be measured in this type exciting the magnet, and thus furnishing the controlling force. Messrs. Paterson and Cooper were amongst the first to introduce these instruments, but their later forms have been considerably improved, and an interior view of one of the ammeters is shown in Fig. 2. The magnet here consists of a bundle of from 50 to 60 No. 26 charcoal iron wires, most carefully annealed, the ends of which are threaded through a soft iron bent up pole-piece of the shape shown. The needle is of shape similar to that employed for the permanent magnet instrument, and of soft iron. It is mounted in the galvanometer coil frame, and this frame, along with the electro-magnet coil bobbins, is rigidly attached to a strong brass frame. There is no necessity here for right and left adjustment, as the needle only deflects in one direction, and things are so arranged that while the galvanometer coil, magnet coils, and pole-pieces are fixed rigidly in position, the bundle of wires forming the limbs and yoke of the electro-magnet can be slid further through or withdrawn further out of the pole-pieces. This alters the strength of the controlling field across the needle, and the adjustment is made until the instrument reads direct, the magnet being securely fixed in position when the latter is correctly ascertained. On each pole-piece is fastened an adjusting plate, the position of which is altered until the deflections are proportional to the currents flowing in the coils. The instruments have thus a straight line law, and are direct reading.

The workmanship and finish of these instruments are of a high order of excellence, and reflect great credit on the resources of Messrs. Paterson and Cooper's establishment.

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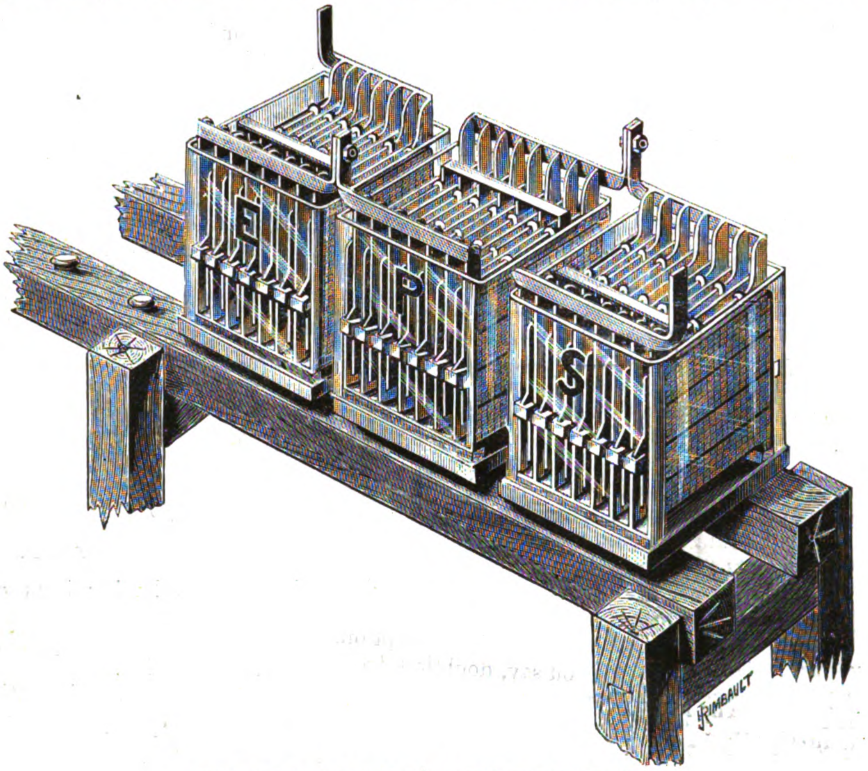
NEW TYPE OF CELL OF THE ELECTRICAL POWER STORAGE COMPANY.

A new type of storage cell which will be issued in future by the Electrical Power Storage Company has been considerably improved in its mechanical detail and arrangement. The containing vessels are larger in order to allow an increase of distance between the opposite plates. This distance is now sufficient to prevent a falling pellet of paste from bridging the gap between the plates. The spongy-lead electrodes are burned together in five places, viz., at the bottom corners (constituting feet on which the section stands), about midway on either side of the plates, and again, at the conducting strip. At the bottom corners a projection is made on the plate which has the effect of raising it, so that there is a space of about 1¼in. clear between the bottom edge of the plate and the bottom of the containing vessel, and, as a result, the powder which may fall cannot deleteriously affect the working of the battery. The peroxide plates are burned together in two places at the conducting strip, and at a carrier strip on the top edge of the plates. They are supported clear of the bottom of the containing cell on insulating saddles, which are carried by the bar which connects the porous lead plates at the side.

The separating arrangement consists of vertical ebonite forks of rectangular section, which give greater rigidity than has heretofore been obtained. There are no glass plates and no indiarubber bands or plugs, the idea being to dispense with any material which can be considered of a perishable nature (the peroxide plates of course excepted). It is believed that as a result of these improvements the battery will be able to work uninterruptedly without attention for at least two years, and that when it requires cleaning after that period the labour involved will not exceed a quarter of an hour for a cell having a capacity of 600 or 700 ampere hours.



THE E.P.S. COMPANY'S NEW TYPE OF CELL.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Dec. 24th*, 1887.

Attention was recently called to the rapid development of the alternating system in this country in the hands of the Westinghouse Electric Company. The system was exploited first barely a year ago, and the latest reports from the Westinghouse Company are that it has now in use or contracted for a total of about 200,000 lights. It has, all told, about 85 central stations installed or in process of construction, and during the month of November it closed contracts for 22 central station plants, aggregating over 30,000 lights. Street lighting also promises to command considerable attention in connection with this new departure, incandescents superseding ordinary street gas burners. About a score of the Westinghouse stations now supply lights for the streets. The Thomson-Houston Company is also doing a large alternating business, and the Fort Wayne Jenney Company is putting out several Slattery plants of the same character. There is a report current, though it lacks confirmation, that the Westinghouse Company may possibly change its type of alternating machine.

Meantime, there are not wanting evidences that trouble is brewing between the Edison Company and the new combination, which includes the Thomson-Houston Company, the Westinghouse Company, and the Consolidated (Sawyer-Man) Company. The war has already broken out in the Courts, and the fire of the heavy legal artillery is being supplemented by a guerilla system of pamphlets. Aside from the legal question involved, the Edison people take the bold stand—and propose to justify themselves in it—that, as compared with the direct system of distribution, the alternating is by no means as economical, and that the alternating introduces, moreover, elements of danger from which the direct system is conspicuously free. It will not be surprising if the Edison Company comes out with some definite statement on these points, joining issue with those who have claimed such enormous saving for alternating systems now in vogue.

Some very interesting work is to be attempted in New York Harbour in the direction of operating incandescent lights on the buoys there. The first trial is to be made on the Robbin's Reef lighted buoy, whose name has probably become quite familiar to English readers in connection with the International yacht races. A 50 candle-power incandescent lamp will be placed on this buoy, and the contract has already been

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made for two thousand yards of double conducting cable to connect the buoy with the shore. The experiments will be carried out by the Lighthouse Board, chiefly under the direction of Lieut. Millis.

Figures have just been made up of the work done on the new electrical subways of New York to date, and they are somewhat interesting. The engineer reports a total length of excavation since last July of 129,918ft. Of single duct conduits for telegraph and telephone service there has been laid 903,180ft., and for distribution purposes 4,050ft. There was room for 13,700 miles of wire. Of single duct conduit laid for light and power wires there were 254,210ft., giving a capacity of 2,542,500ft. of wire. In addition to this, which was intended for arc-current purposes, there were 186,745ft. of conduit for incandescent lighting. This is a pretty good record of work; but the Subway Board are experiencing some difficulty in getting the electric spider to bring its web into their parlour. The United States Illuminating Company has brusquely declined to lend an ear to the seductive invitations of the Board, and it seems quite likely that this matter of forcing the electric light companies into the subways will have to go before the Courts for adjudication.

Much interest attaches to the action which the Police Commissioners of this city are about to take in regard to the establishment of a system of electrical police alarm. The commissioners have about $100,000 to spend, and are receiving estimates on a basis of 500 alarm boxes, although as there are already about 1,000 posts over which police jurisdiction extends, it will be seen that the contractor stands to handle not less than about a quarter of a million of the city's money, and doubtless a great deal more. The commissioners are now looking into the merits of the various systems, among which is the well-known Gamewell and the Herzog teleseme, which includes a dial on which are 200 or 300 words and indications. An early decision is expected in the matter. It is said of one of the systems that the Republican Commissioners are inclined to favour it, while the Democratic Commissioners are against it. As such matters ought to be settled entirely on technical and practical considerations, it might seem that politics have nothing to do with the case; but they have. One reason why so much importance attaches to the present decision is that the action of New York is likely to be followed by other cities. The main idea is to have the police at all times in direct communication with headquarters, and wherever this has already been attained its advantages have been manifest.

One of the evening papers here has just published an interesting article, evidently by one who is pretty well informed, on Mr. Edison's "lieutenants"—that is, the men who have shared his confidence and have helped him to bring out and perfect his many inventions. It is interesting to know that one of the most prominent men in the list is Mr. Charles Batchelor, an Englishman who came here some twenty years ago in the employ of the Coates Thread Company, of Manchester, and thereupon formed an acquaintance with the great inventor which has grown more and more intimate as the years roll by. Mr. Batchelor, who is well known in Europe through the hard work he did there in introducing the Edison system of electric lighting, is now giving himself up almost exclusively to laboratory work, and the article mentions the fact that ever since the Menlo Park days Mr. Batchelor has had a contract with Mr. Edison, that has never been reduced to writing, but which is thoroughly carried out, that he is to have one-tenth interest in profits of all the products of the laboratory. The exact manner in which this contract is carried out is unknown, but its existence is highly creditable to the good faith in each other and to the strong friendship of the persons interested. It may be mentioned in this connection that another Englishman who enjoys Mr. Edison's confidence in a marked degree is Mr. Samuel Insull, who has practically charge of the huge Edison Machine Works at Schenectady, where, by the way, is another Englishman, Mr. Phillips, whose brother is a member of the firm of Johnson and Phillips. It might be mentioned, too, that Mr. Edison has just taken into his laboratory **Mr. A. E. Kennelly**, of London.

Americans are generally supposed to be well satisfied with their patent system, but this is hardly the case, although the system is eminently a good one. The lapse of time has brought to notice many points in which it may be improved. The National Electric Light Association, through its general counsel, Mr. Arthur Steuart, has gone so far as to prepare a Bill to appoint a Commission for the revision of the Patent Law, and on Tuesday, December 20th, Mr. Steuart read a paper on the general subject before the American Institute of Electrical Engineers, calling attention in detail to the reforms considered necessary, and to the manner deemed best for securing them. The meeting was a very interesting one, but brought out great diversity of opinion on the subject both in the speeches and in the correspondence submitted. While there was a general desire for various reforms, such for instance as the establishment of a distinct Patent Court, there was felt by some to be danger in urging on legislation at this time, and in placing the whole patent system at the mercy of grangers and others whose influence would be inimical, and could not be despised. Another objection raised by some persons was that it was unwise to agitate the matter in view of the Presidential campaign of next year, when public attention would certainly be riveted on such leading issues as that of Protection *versus* Free Trade. In all probability the Bill prepared, which has already been printed in the electrical journals, will be laid before the Patent Committee of Congress, and will be pushed.

CORRESPONDENCE.

BRADFORD ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention having been called to your article on this subject in your valued journal of the 23rd December, I venture to mention one or two points which, unless corrected, may lead to misconception.

You say, doubtless from information given you, that the corporation and a local company who have effected an installation here have each voluntarily incurred a certain risk—the one by invading the rights of the borough, the other by permitting its rights to be invaded. You add that of the two "we are inclined to think the corporation are most responsible, seeing that by condoning a private installation in the first instance they virtually confessed they had no intention of doing the work themselves."

The fact is that there has not been any invasion of the corporation rights by the company, although once attempted, and, consequently, the corporation have not permitted any invasion. The company carry on business under the Companies Acts without any licence or Provisional Order from the Board of Trade, and therefore free from all the onerous obligations which Government insist upon when they grant a licence or Provisional Order. They knew from the first that the corporation have an Electric Lighting Act, with large powers in addition, under a local Act, for preventing anyone from carrying electric wires over or along any street. The buildings of the company are so situated that they can convey their electric apparatus into several adjoining places of business without crossing any street, and this the corporation cannot prohibit them from doing. The Board of Trade were duly apprised of the proceedings of the company at the end of 1886, but did not feel at liberty to interfere.

At subsequent dates the company applied to the corporation for leave to carry their wires over the streets. This the corporation refused, and the company acquiesced. On one occasion the managers of a leading club contrived to get a cable from the company's works connected with the club across one of the highways, but as soon as the existence of the cable was known the corporation required it to be removed; and this was complied with.

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The corporation have always contemplated exercising their powers, but the collapse of all the electric lighting schemes in other towns induced the corporation to stay their hand until further experience had been obtained. In thus acting they were guided by the electric engineer whom they consulted, and now that the subject of electric lighting appears to offer more satisfactory results the corporation have determined to establish an installation upon a modest scale, but so arranged as to admit of extension if the measure of success they may attain warrants them in so doing.

I am sure you are anxious to have everything connected with this operation of the corporation accurately stated, and therefore feel it due to you to mention the above circumstances.—Yours, &c., W. T. M'GOWEN, Town Clerk.

Town Clerk's Office, Town Hall, Bradford,
3rd January, 1888.

"MEDICAL ELECTRICITY."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Perhaps my experience of medical electrical quacks is, since you have ventilated the subject, as interesting as any one's.

I was invited by an "eminent consulting medical electrician" to attend a lecture at his rooms, and I accordingly went. The lecturer stood at a small table, on which were belts innumerable and various other wonderful appliances, and also a small motor with a fan mounted on the axis, a bell, and a Holtz machine, all *ostensibly* the invention of this "eminent consulting medical electrician." The first part of the lecture was dull, but showed talent. The lungs were compared to a sponge, various other essential portions of the human frame were discussed, and so forth. At length the electropathic belt was exhibited and described. The belt is worn next the skin; on the inner side of the belt is a series of metal discs, copper and zinc, and we were told that when the salt, moist skin of the body came in contact with the discs, a current of electricity was set up, depending for its strength on the number of the discs. He then proceeded to illustrate this by making the current produced in this way by a belt on his body ring a bell and drive the fan on the motor. This I could not stand, so jumped up and told him that if he intended to convey the impression that such a current could drive a fan in the way described, I knew it was absolutely untrue. I asked him if he had a battery anywhere about him. He was very wroth, and loudly denounced me for interrupting, said *it was not allowed*, and added that I should have every opportunity of examining the apparatus afterwards, and that the "electricians" downstairs would explain everything to me. However, when the lecture was over he promptly vanished, but we found, of course, a large battery under the table.

I then got hold of one of the "electricians" down stairs and cross-examined him, and he assured me the current of electricity produced by the salt skin of the body and the discs was the only current employed by them in their "cures." Before, however, I left, I told him I was an electrician myself and knew that what he said was quite untrue. He then acknowledged that when people came to them for treatment, they were placed in a chair under which was a strong battery, which was then coupled up in some way with the belt. I must not forget, however, to mention that before this confession was made to me, the same "electrician" assured me that the "current" had often been measured by means of an electrometer. I asked to see this experiment, and was told they were sorry to say the electrometer was out of order. I suppose the strong current fried it up.

The most thriving electrical quack establishment I ever saw was in Brooklyn, U.S.A., where they had the most elaborate suite of rooms decorated with gilt, with soft subdued pink lights burning. This establishment sold whole suits of clothes of the "belt" type, and the modest price for a suit was, I believe, $150. The sale was enormous.—Yours, &c.,

J. M. V. MONEY-KENT.

Connaught Mansions Victoria-street, S.W.

THE CENTRAL ELECTRIC LIGHTING STATION AT LUBECK.

(*Translation of a letter in the "Hamburg Correspondent."*)

Let me first give a short history of electric lighting in Lübeck. In February, 1884, the German Edison Company asked the Senate for a license and concession for the supply of electric light for Lübeck. This request was not granted, as the town intended to do the work itself. A committee was elected for the thorough investigation of the matter, and on the 19th July, 1886, the Senate and Council decided, after hearing the report of the committee, upon erecting an electric plant under the auspices of the State of Lübeck. Tenders for executing the work were solicited, and S. Schuckert, of Nuremberg, was given the contract in February, 1887, for the whole plant—dynamos, apparatus, instruments, and cables, and including the connections with the installations of private buildings. It was only after Easter, however, that the contractor could commence with the building of engine and boiler houses. The erection of these buildings, together with the placing of the boiler, the steam engines and dynamos, and the laying of the cables and installations, took a much longer time than was at first anticipated, and the month of August came before the contractor could proceed with the erection of the steam engines, dynamos, and the electric apparatus. Simultaneously with the completion of the whole of the works in the engine house, the cable last put underground was tested. After sundry trials in the engine house and in a small number of private buildings had been made in the beginning of the month, on the 16th of November the whole system was shown in operation, including about 1,000 glow lamps (16 candle-power) and about twenty arc lamps of 600 candle-power, to which exhibition the members of the Senate and Town Council were invited. This first trial, as well as subsequent ones, proved to be a great success, and the plant has shown itself to be well executed in all its details. The whole system was started working on November 22nd, 1887, and has earned the fullest commendation, not only from the knowing ones but from the general public. Originally the plant was only intended for a regular supply for 3,000 glow lamps (10 candle-power) and 100 arc lamps (400 candle-power), requiring 250 horse-power. However, when laying down the plant it was thought better to have a respectable reserve, and also to make provision for the extension of the system by one half. The underground cables were at the same time prepared so as to give sufficient conducting power for the calculated increase.

The engine house and chimney are erected in the centre of the town. The engine house is closely connected with the boiler house. Nearest to the entrance is a single cylinder steam engine, of about 50 horse-power, with a wrought-iron flywheel of three metres diameter. Behind are placed four dynamos of the well-known Schuckert construction. Each dynamo gives a current capable of supplying electricity for 700 16 candle-power glow-lamps. Two more dynamos of the same capacity will be fixed when the installation is extended, the foundations for which extensions have already been laid. For propelling the four dynamos already fixed, two large compound steam engines of 200 horse-power each have been obtained, and each of them is furnished with a flywheel of $3\frac{1}{4}$ metres diameter. Both engines are fitted with condensing apparatus. Along one side of the engine house is placed the common driving shaft, which is driven by the engines by means of flax ropes, the dynamos being driven from the shaft by means of leather belts. The transmitting shaft is supplied with frictional clutches and pulleys, by means of which both the steam engines, as well as the dynamos, can be adjusted at will while the machinery is in motion. Close to the engine house, and separated from it by a wall, is the boiler house, in which are three of Heine's patent water-pipe boilers, manufactured by Borsig, of Berlin. Each boiler has a heating area of 70 square metres. These boilers are in connection with a chimney 40 metres high. On the other side of the engine house, at the same altitude as the dynamos, is placed a most interesting apparatus provided with controllers and regulators, for use not only in making the electric fluid, but for delivering it. From the dynamos are cables bedded under the floor leading to the switch-board, and from thence beyond they lead to two strong copper rails which take the entire current from the dynamos. With the aid of the switch-board the current from any of the dynamos can, while the engines are in motion, be excluded or otherwise, without influencing the remaining dynamos. The pressure, in spite of the occasional occurrence of irregularity in the motion of the engines, is, in a most simple manner, kept at an exactly normal pitch through rheostats. Nine couples of cables branch from the above-mentioned copper rails which directly lead the current to the division centres. Each pair of cables is provided with a current measurer, which indicates the pressure upon it at any time, and also with a regulator, which automatically regulates

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the current, and keeps it at the pressure required by the consumer. Branch cables lead from the division centres through the streets and supply the electricity throughout the town. Altogether there are about 10,000 metres of lighting cables laid through the principal streets, the diameter of which measures, according to the strength of the current, from 40 to 240 square millimetres. The city of Lübeck is the first in Germany to decide upon constructing an electric central station at its own expense and under its own municipal supervision, and that this step is being recognised as one worthy of imitation may be learnt from the fact that already a great number of towns have followed its example, or are about to do so.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions*

17,905. C. GASSNER, JUN. London. Improvements in or relating to the manufacture of galvanic dry elements. December 29.

17,926. W. E. HAYNE. Safety fuses for electrical circuits. December 30.

17,965. F. REDMOND. Machines for cleaning windows, &c., by electrical power. December 31.

17,966. Y. RHODES. Electric batteries, and applying same to lighting miners' safety lamps. December 31.

18,015. E. J. BERNHEIN. Electrical connection for a number of telephonic stations. December 31.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

December 31, 1887.

15,344. A. M. CLARK. London. Automatic switch and governor for electric lighting purposes. (The Electrotechnische Fabrik Cannstatt [Wirth and Co.], Germany.) November 24.

16,865. L. R. DAVIES and M. SHEARER. London. Improvements in coupling up batteries for lighting and other purposes. December 23.

PATENTS SEALED.

December 27, 1887.

16,141. J. R. TOZELAND and H. F. TOZELAND. Portable electric call alarm. December 9, 1886.

16,177. J. GRIFFITHS. Denbighshire. An improved form of wind motor for electric lighting and other purposes, and mode of regulating and controlling the machinery driven thereby. December 10, 1886.

4,135A. H. J. HAIGHT. United States. Improvements in electro-magnet clock time transmitters. March 18 1887.

4,303. W. MAIN. United States. Improvements in and relating to secondary and other electric batteries. March 22.

LEGAL INTELLIGENCE.

Pearson v. The Maxim-Weston Electric Light Company.

An action was heard last week in the Glasgow Sheriff Court, brought by Ebenezer Westmoreland Pearson, electrical agent, 23, Wilson-street, Hillhead, against the Maxim-Weston Electric Light Company, carrying on business at Buchanan-street, Glasgow, for £525 in name of salary and damages. After hearing debate, Sheriff Erskine Murray sustained the defenders' plea of no jurisdiction, pursuer having no cite in Glasgow, and found them entitled to expenses, modified to one-third, as he thought that defenders had exceeded their powers in taking possession of pursuer's office and furniture.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended December 23rd, 1887, amounted to £4,993, and for the week ended December 30th to £4,102.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of December, 1887, was 3,925, estimated to produce £3,300, against 3,695 messages, producing £3,125, in the corresponding month of 1886. The traffic receipts for the month of September, 1887, estimated at £2,500, realised £2,494.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for December, 1887, amounted to £2,004, against £1,782 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of December, 1887, amounted to £57,703, and to £52,823 in the corresponding period of 1886.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of December, 1887, amounted to £38,908, and to £40,539 in the corresponding period of 1886.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for December, 1887, amounted to £21,600; from 1st January to 31st December, 1887, they amounted to £264,480; while for the corresponding months of 1886 and 1885 they were £258,600 and £284,720 respectively.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended 31st December, 1887, were £4,300.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 30th December last, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £3,318.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half-month ended 31st December, 1887, are £2,826, as compared with £3,089 in corresponding period of 1886. The September receipts, estimated at £4,357, realised £4,453.

CARBON TRADE.—We are requested to state that after 1st January the Globe Electrical and Engineering Company, of 7, Carteret-street, Westminster, will act as sole London agents for the Barnsley Carbon Company, of Barnsley, and will supply both carbon rods and plates from their London stores at the same price and terms as the Barnsley Carbon Company.

We are asked to notify that in future the style of the General Electrical Apparatus Company will be the General Electric Company (G. Binswanger and Co., proprietors).

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Jan. 4.	Business Done Week Ending Jan. 4. Highest.	Lowest.
Anglo-American	37, 38	37	36½
Do. Preferred	61, 62	61	—
Do. Deferred	13, 14	13½	—
Brazilian Submarine	11⅞, 12⅛	12 1-16	11⅞xd.
Cuba	12¼, 12¾	12⅝	12¼
Do. Preference	18, 19	—	—
Direct Spanish	3½, 4	—	—
Do. Preference	8½, 9½	9	—
Direct United States Cable	8⅜, 8⅝	8⅝	8½
Eastern Telegraph	11⅜, 11⅝	11⅜	11¼
Do. 6 per Cent. Preference	14¼, 14¾	14¾	—
Do. 5 per Cent. Debentures, 1899	106, 109	—	—
Eastern Extension	12⅜, 12⅝	12 7-16	12⅜
German Union	9¼, 9¾	—	—
Globe Telegraph and Trust	5⅜, 5⅝	5½	5 7-16
Do. Preference	13⅛, 13⅝	13⅜	13¼
Great Northern	13½, 14	14	13⅝xd.
Indo-European	37, 39	38	—
London Platino Brazilian	4, 4½	4 7-16	4¼
Reuter's	8, 8½	8	—
Submarine	130, 140	—	—
West Coast of America	4¾ 5¼	5¼	4¾xd.
Do. Debentures	108 112	—	—
West India and Panama	¾, 1	—	—
Do. 1st Preference	9½, 10	9⅜	9½
Western Brazilian	8¾, 9	8 15-16	8 13-16
Western Union 7 per Cent. 1st Mortgage	120, 125	—	—
Do. 6 per Cent. Sterling Bonds	101, 104	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	9-16, 11 16	—	—
Oriental	¼, ⅜	5-16	—
United Telephone	11½, 12	12	11 15 16
United River Plate Telephone	4¾, 5¼	5	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	2¾, 3¼	3⅜	2⅝
Do. (fully paid)	3½, 4	4¼	3½
Swan	1⅛, 1⅜	1⅜	—
Maxim Weston	3-16, 5-16	—	—

MISCELLANEOUS.

Telegraph Construction	38, 39	38⅜	38¼
India Rubber, Gutta Percha and Telegraph Works	21, 22	22	21½

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 504.—Vol. XX. FRIDAY, JANUARY 13, 1888. Price 4d.

NOTES.

The sixth issue of the Electricians' Directory for 1888, published at this office, is now ready. The present year's edition has been greatly enlarged and improved, both in the matter and arrangement of its contents. Information likely to be of use to the practical electrician, both for the scientific and commercial aspects of his business, will be found in this Directory. Several new and important features have been introduced, adding considerably to the value of the work as a book of reference.

We are at length enabled to announce that an agreement has been arrived at between the United and the National Telephone Companies, whereby the metropolis will shortly be placed within speaking distance of the Midland Districts, and ultimately also with the North of England. A heavy copper line will at once be laid to Coventry, and from there it is intended to fork to the left to Birmingham, and thence to Liverpool and Manchester, and to the right to Nottingham, Sheffield, and Leeds. The details are not yet, however, fully decided upon, but it may be anticipated that the line will be open to Birmingham within a few months from the present time.

The Great Sewage Question is about to be solved once for all by the application of electricity. So the *Standard* announced to the world last Saturday morning; and the Metropolitan Main Drainage Works, which are under process of reconstruction for the application of a chemical process, will of course be stopped until Mr. W. Webster, F.C.S., has perfected his experiments—which, however, from the *Standard's* account, do not appear to have gone beyond the contents of a tumbler or a glass bottle. Mr. Webster's method—or, shall we say, idea?—is to transmit a current of electricity between two metallic electrodes through the sewage, the effect upon which is to suspend the solid matter instead of precipitating it. Had the *Standard's* judgment on this "invention" been first subjected to the same treatment, and with exactly similar results, we should have regarded the scheme more hopefully. Still the facts, as stated, are interesting and even important apart from the sewage question, and we should be glad to learn more about them.

Since writing the above we have ascertained that the experiments referred to by the *Standard* are being carried out on an extended scale, and that no decisive opinion should be formed upon the facts made public by that journal.

Apart from the nonsensical or fraudulent charlatanism with which the application of electricity in medicine is unhappily too often associated, we take it that in a minor degree the scientific development of the subject is retarded by the unscientific way in which it has been handled by qualified medical practitioners. It is difficult for an electrician to study the literature of the subject from his own point of view without some feeling of impatience. We have before us a work of recent date treating of the application of electricity to medicine, written by a medical man whose qualifications in his own department of science are beyond dispute. Yet his book opens with a broad assertion which, though possibly true, has never been scientifically demonstrated. "In its natural state," we are told, "electricity pervades all things, animate and inanimate, throughout nature; *without its invigorating influence all life would become extinct.*" The italics are our own, but the sentence painfully reminds us of the familiar assertion of the advertisements, "Electricity is Life," or, as in a variation we have recently met with, "Electricity is the Physical Basis of Life." A little further on we find that the author has solved to his own satisfaction the vexed question of the seat of E.M.F. in the voltaic cell, and that he is further able to announce that "all molecular disturbance, however excited, must give rise to electrical disturbance." This again is an assertion which we are not so rash as to deny off-hand, but we should be grateful for a somewhat more detailed explanation of the author's proofs on a matter of such profound interest.

Still another obstacle in the path of an electrician who may desire to learn something of the application of electricity to medicine lies in the terminology employed. Of amperes and volts the average medical electrician is, of course, entirely innocent. A favourite mode of indicating resistance is as so many Atlantic cables. The reader is supposed to be overwhelmed with astonishment on learning that the resistance of his own body probably exceeds that of two Atlantic cables. Such terms as "Franklinism" and "Galvanofaradisation" are frequently met with, and are well calculated to alarm the uninitiated. Seriously, however, we do not see why a doctor who writes upon this branch of his profession should not take the trouble to use, so far as possible, both the methods and the language of the electrical profession. He certainly would

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not compromise his dignity by so doing, and if, as is so much to be desired, the subject is ever scientifically developed, it will surely be by doctors who become electricians and not by electricians qualifying for the medical profession. The Institute of Medical Electricity which Mr. Newman Lawrence proposes to establish, and which is receiving support from some of the leading men in each profession, should, however, go far to remove these complaints; at any rate, it seems to be a step in the right direction.

OUR readers will probably agree with us in thinking that M. Menges' thermomagnetic motor, whose advent we foreshadowed some time since, and which we now describe at length in another column, will at once take rank as the most promising attempt which has yet been made to produce electrical energy from the direct conversion of heat; indeed, so far as we have yet been able to form an opinion, it seems to us to bid fair to bring that long-sought consummation within measurable distance of practical realisation. It will be seen that M. Menges' apparatus differs from Edison's pyromagnetic generator principally in two points, each of which is of very great importance—(1) by means of an adaptation of the well-known experiment of Schwedoff the necessary rotation is performed in an entirely automatic manner; (2) the core upon which the armature coils are wound is *not* subject to variation of temperature. Two of the most serious difficulties which occur in the pyromagnetic generator are thus entirely obviated by M. Menges.

OF course, like every other heat engine, the efficiency of the apparatus will be a function of the difference which can be maintained between the maximum and minimum points of temperature; but in this case the efficiency clearly will not be directly proportionate to this difference, but will depend on the curve connecting the magnetic permeability of the metal with its temperature. According to some old experiments of Rowland, the maximum intensity of magnetisation of nickel at 12° C. is 494 C.G.S. units, and at 220° C. 380 units, while, according to the text-books, at 350° C. nickel "loses its magnetic properties." M. Menges is now engaged in investigating this point, and we hope shortly to publish a complete curve, from which the best working temperatures may be deduced. It will then become a question at what speed the armature should run so as to combine the most efficient conditions of temperature variations with the production of maximum E.M.F. It is evident that the slower the speed the more easily the change of temperature can be effected, and the greater, therefore, the variation in the strength of the magnetic field; but of course the rate of cutting lines by the armature is correspondingly less. All these points will require careful experimental development.

IF both Edison and Menges had not already got machines of this type to work we confess that we should have been inclined to fear that at any moderately rapid speed of rotation a practically uniform temperature would, sooner or later, be arrived at. We are glad to learn that this is not the case.

ONE of the most obvious developments of M. Menges' idea evidently lies in its application to small motors. If permanent magnets are used for the field no wire at all would be required on the armature, and we should have as simple, and, we may hope, as practical an apparatus as could be devised. A steel magnet, soft iron pole-pieces, a nickel "distributor," with an iron ring as armature, and the apparatus would be complete. There certainly appears to be a most promising field in this direction. It may also turn out that a motor of this kind, coupled up with an ordinary dynamo, will prove a more practical method of generating current than the combination of motor and generator in one machine.

As to output, this will necessarily be lower than in an ordinary dynamo; but we must not lose sight of the fact that the comparison of weight of material lies with the dynamo *plus* the engine or other source of motive power. M. Menges is not prepared to give detailed figures on this point at present, but may be expected to do so shortly.

"IT is about time," says our Boston (U.S.) electrical contemporary, yclept *Modern Light and Heat*, "for the 'Electricians' Dictionary' (published by *The Electrician*, London) to appear." We are somewhat at a loss what to make of this observation, particularly when we are further instructed that "copies should reach this office not later than the middle of January." Seeing that we know nothing of a dictionary published at this office, we greatly fear that by the middle of January our contemporary will be sadly disappointed. We can only explain our contemporary's evident misunderstanding on one of two suppositions—(1) the word "Dictionary" is a printer's error for "Directory"; or (2) the reference is to a "Cyclopædia of Electricity" which has been advertised in our columns as a forthcoming publication, but with which we have not and have never had any other connection.

WE can, however, appreciate our contemporary's anxiety to obtain a "dictionary" at an early date, inasmuch as in the same issue we are taken to task for remarking that "the primary battery epidemic had broken out in a severe form in New York." On this we are referred to the scriptural admonition about extracting a mote from a brother's eye, and much is said which must perforce be admitted to be true enough about the extravagances of primary batteryists on this side of the water. But *Modern Light and Heat* evidently fails entirely to appreciate the full meaning of the word *epidemic.* We may mention that the *Electricians' Directory* is now ready.

THE *Progressive Age* states that the house in which Prof. Morse, the inventor of telegraphy, was born is still standing in Charlestown, Mass., an object of very little interest to the passing throng. The residence in which Morse lived at the time of his death in New York City is unmarked, save by a marble slab, about six inches square, set in the front wall, reciting the brief fact of the inventor's death within. Our contemporary continues:—"The world owes so much to that great inventor that it does seem as though there ought to

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exist a sufficient number of public-spirited gentlemen, who have made vast fortunes out of telegraphy, to gather a fund, which should be used to purchase either or both of these buildings, and instal therein a museum of curiosities denoting the stages of advancement in electrical science."

Garston.—The sugar refinery and docks of Messrs. Bostock and Co., Garston, are to be lighted by electricity. The Lever system is the one to be adopted.

The Commercial Cable Company.—Mr. J. W. Mackay has presented the whole of the *employés* of the Commercial Cable Company with a fortnight's salary as a Christmas present. Needless to say this generosity is highly appreciated.

"Every Man his own Lawyer."—Messrs. Crosby Lockwood and Son send us a copy of the 25th edition of their well-known legal handbook under the above title. This edition has been "reconstructed, thoroughly revised, and much enlarged."

The Anglo-American Brush Company's Almanac. — This company has sent us a handsomely got-up sheet almanac, containing a photograph of a Victoria dynamo, driven by friction gear from a Brush engine. A number of useful electric lighting data are also supplied.

The Royal Victoria Hall, Waterloo Bridge-road, S.E.—The January lecture arrangements at this hall are as follows:— Tuesday, January 17th, F. W. Rudler, Esq., F.G.S., "Caves and Cave Men"; Tuesday, 24th, Prof. Bonney, F.R.S., "The Oldest Monuments in Brittany and Britain"; Tuesday, 31st, Prof. Ramsay, "Speech made Visible, or Picture Writing as it was and as it is now."

Obituary.—We regret to record the death of Mr. George Henley, M.S.T.E. and E., and brother of the late Mr. W. T. Henley, of North Woolwich. Mr. Henley died on the 8th inst. at his residence, 47, Drayton-park, Highbury, N. We regret also to record the death of M. Raynaud, of the French Telegraph Service, who, as reported in our last issue, was shot at and wounded by an assassin. M. Raynaud was forty-four years of age.

An Electrical Railway Transfer Table.—At Chicago a transfer table, weighing about 15 tons, in the shops of one of the railway companies, has been fitted with an electric motor of 7½ horse-power. Power is derived from a dynamo at a distance of 750ft. The tractive resistance of the table when loaded with a Pullman car is about 1,500 pounds. The gearing is of a somewhat elaborate description, but is said to work very well, and its manipulation is quite simple.

Telephone from House to Dynamo Machine.—Lord Armstrong, whose dynamo machine is situated some 700 yards from his house, has connected the two by means of a telephone. We are informed that a pair of A type "Swinton" telephones, supplied by the Equitable Telephone Association (Limited), are employed, and though the telephone line runs quite close and parallel to the electric light wires throughout the entire distance, the induction is not sufficient to cause any inconvenience.

The German Telegraph Service.—The German Post-Office is this year expending some £375,000 additional for the telegraph and telephone services, of which the latter gets about £150,000. In Berlin and Hamburg the wires are going underground at a cost respectively of £75,000 and £25,000. Copper is now used on all new lines. Multiple trunks are to be erected between Cologne and Frankfort, Berlin and Dresden, Berlin and Frankfort, and Berlin and Cologne. These are estimated to cost £41,000 odd, while £5,000 is to be devoted to altering existing iron and steel lines to copper.

Arc Lamps and Alternating Currents.—At his first juvenile lecture on "The Application of Electricity to Lighting and Working," given to a crowded audience at the Society of Arts, on Wednesday evening, the 4th inst., Mr. W. H. Preece, F.R.S., showed, for the first time in public, an arc lamp fed by alternating currents from a central station. The lamp used on this occasion was a "Brockie-Pell," and the bright, white light given was steady enough to please the most critical eye. The current was supplied by the Grosvenor Gallery station, which is over a mile away from the society's hall.

Newcastle Exhibition Awards.—We understand that the list of awards published by the Exhibition authorities was confessedly preliminary and incomplete, and that several awards, through incomplete description of the article or imperfect statement of the feature for which the award was made, have not yet been published. Among these there is at least one of considerable interest to electrical engineers, which has been withheld for the present on account of its appearing in more than one class. It is expected that these awards will be finally confirmed at the next meeting of the council.

Another Westinghouse Enterprise.—A company called the Overhead Conductor Electric Railway Company, of Pittsburgh, of which Mr. G. Westinghouse, jun., is president, has just been organised, and announces that it has acquired patents of Joseph R. Finney for supplying electricity to moving vehicles by means of travellers upon overhead conductors. The circular goes on to say that after a thorough investigation these patents are believed to cover the entire right to use such appliances, and legal proceedings will be taken against all infringers. Licences may be obtained at the uniform rate of $250 per car.

Temporary Lighting.—The occasion of the annual ball given to the staff of Thorpe Asylum, near Norwich, on the 6th inst., was this year made especially agreeable by the lighting of the hall by the means of four 200 candle-power incandescent lamps. The motor, driving one of Messrs. Paris and Scott's C type No. 2 dynamos, was a new rotary engine brought out by Messrs. Sturgess and Towelson, of Norwich. Motor and dynamo were coupled together and bolted to a cast-iron bedplate 3ft. by 2ft., running 1,300 revolutions per minute. The light was noticeably steady, and the hall remained cool, even at the early hour of three in the morning.

Nottingham.—The application of electric motors to small industries is effectively illustrated in the show room of the Wheeler and Wilson Company, in Nottingham, where a number of sewing machines are shown at work, driven by a half horse-power Immisch motor, receiving its current from a dynamo in one of the factories about 200 yards distant. The work has been carried out by Mr. W. B. Sisling, late electrical superintendent of the Newcastle Exhibition, and great interest appears to be taken in the little motor by the spectators. We compliment the local manager of the Wheeler and Wilson Company on his enterprising display, and have no doubt that it will lead to business both in sewing machines and motors to drive them.

An Automatic Chess Recorder.—Messrs. Woodhouse and Rawson have on view at their show rooms an ingenious apparatus, devised by Dr. Wurstemberger, of Zurich, for obtaining an automatic record of the moves upon a chess-board. The

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pieces are provided with stems fitting into holes at the centres of the squares, and in so doing a contact is closed which, through the medium of a relay, actuates a type-printing wheel by which the index number and letter of the square from and to which the piece is moved are recorded. By an ingenious arrangement the moves of the black pieces are recorded on a different part of the tape from those of the white. This is accomplished by making the pegs of the white pieces entirely of wood, while the black pieces carry a metal stud which closes a contact and shifts the wheel laterally. A good deal of ingenuity and skill have evidently been devoted to the apparatus, and we understand that it is anticipated that a far more extensive field of usefulness will be open for its application than that for which it has ostensibly been designed.

Paris.—The Paris Municipal Council has passed a resolution authorising the expenditure during the current year of one million francs for the establishment of a municipal central lighting station to supply electricity for lighting the Hotel de Ville and the surrounding district. The details of the scheme are not yet decided upon, but it is understood that the machines will be placed in the Rue des Halles, and would light the Hotel de Ville, the Markets, the Place du Chatelet, and the Avenue Victoria.—The Council have also recently issued a set of regulations to be complied with by companies undertaking the distribution of electricity. Underground cables are insisted upon. Licenses will be granted, without conferring monopoly, for a period of 18 years. The maximum rate of charge to be permitted is fixed at 6 centimes per carcel hour, or 60 centimes per (French) horse-power-hour. The company is to be liable to a tax of 100fr. per annum for each kilometre length of conductor, and 10 per cent. upon its gross receipts. The city has the right of buying out the company at the end of five years.

Snyers' Clutch Pulley.—M. Raymond Snyers, of the Louvain University, has designed a novel clutch which appears to possess some valuable properties. It consists of a disc, carrying on its face a large number of short wires, set vertically; these wires catch upon projections, set in the pulley, to which the disc is opposed. The clutch is thrown in or out of gear by a movement which shifts the disc nearer or further from the pulley, or *vice versâ*. In a clutch 21¼in. diameter, and capable of transmitting 26 horse-power at 100 revolutions, the number of wires employed is 14,400. Each of these wires is deflected at its extremity to the extent of two millimetres, and exerts a power of about 50 grammes, or less than one ounce. A clutch of this type, 11in. in diameter, has recently been fitted to a shaft, transmitting motion from a six horse-power Rajot petroleum engine to a Gramme dynamo in a shop at Brussels. The dynamo runs at 1,500 revolutions, but the engagement and disengagement are said to be effected instantaneously with very little pressure.

An Electrical Type-Setting Machine.—Messrs. S. Capehart, S. G. Goodson, and C. L. Redfield, of Minneapolis, have designed a machine, actuated by electricity, for setting type, or rather for making a matrix from which casts can be taken. The letters are punched into a strip of cardboard the width of a column, from which a stereotype is made in exactly the same manner as stereotypes are now made from pasteboard matrices. The work of punching the dies in, of feeding in the cardboard, and of preparing it for the next stroke is all done by electricity. The operator simply has to push the die plate to the right place and strike the key. Mr. Redfield, who thinks the invention will create as much of a revolution in printing as Gutenberg did, points out that the application of electricity to the work opens up a field the wideness and novelty of which makes it difficult of comprehension. For instance, he says there is nothing to hinder a press agent in Chicago from sitting down to his machine and simultaneously making matrices on similar machines in Minneapolis and St. Paul, Milwaukee, Kansas City, and Omaha. One man operating the electro-matrix machine will supplant at least five men setting type.

Vienna.—The Vienna correspondent of *Industries* states that the Imperial castle at Laniz, which is situate in the middle of magnificent forests, was some time ago partly fitted with a glow lamp installation. This has proved so successful that the Emperor has ordered an extension of the installation, so that every room in the castle may be lighted by electricity. The total number of glow lamps to be fixed amounts to about 1,000. An extension of the installation in the Vienna Town Hall has also been resolved upon by the municipal authorities, notwithstanding the fact that the working cost of the existing installation was found very much higher than originally estimated. The installation at the Vienna Opera has been thoroughly examined and found in perfect order by two officers of the Vienna Technological Museum. Prof. von Waltenhofen is now engaged in an examination of the internal arrangements of the electric light installation of the Court Theatre, especially as regards the insulation resistance of the circuits. This installation will be suppled with current in the same way as the Opera House, from the Central Station in the Schenkenstrasse, but will not be ready before spring.

The Electric Light in Spanish Theatres.—In our issue of November 18th, we referred to a proposal to make the use of the electric light compulsory in Spanish theatres. We now learn that tenders are invited at the Ministry of Finance, Madrid, for the supply of the electric light in the Teatro Real. The full conditions are given in the *Industria é Invenciones*, a Barcelona technical journal, of December 31st. We may state briefly that the conditions provide that incandescent lamps shall be used in the body of the theatre, and arc lamps, under certain restrictions, on the stage and outside the building. Satisfactory provision must be made for obtaining absolute certainty of light, non-explosive generators, silent machinery, a supply of light equal to the maximum produced by gas, the necessary combinations and suitable machinery for easily and safely producing the desired scenic effects, &c. The installations for the stage, for the body of the theatre and exterior, and for the other parts of the building, will have to be separate, and the installation must be exclusively for the theatre. Three months are given for the presentation of proposals, and the light is to be definitely ready for use on the 1st September next.

Early Days of the American Telegraphs.—The *Electrical Review* of New York says that "The talk of a new telegraph line between New York and San Francisco has aroused the old timers in New York to lively reminiscences of the building of the first line across the plains. One pole, 100 miles west of Laramie, was set up four times, and each time hacked down by Indian tomahawks. Each time there was a bloody skirmish with the redskins for temporary possession of the stump. At last the pole was given to a young man who is now high up in the management of the Western Union. He laid a mine in the hole, set up the new pole, trailed the fuse to an ambush of rocks close by and waited with two armed friends. Then a band of eight Sioux came along and held a war dance around the pole. When the mine was fired all but three were killed and those three carried off Minie balls with them. The powder blew up the pole again, but it cleaned the hole out nicely for a new one, which was thereafter let alone. This story was told with great *éclat* at Del-

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monico's, and was the signal for more bottles and more stories. It is curious what enthusiastic story tellers are to be found among New Yorkers who have seen life in the Rockies."

Electric Communication with Lightships.—At the monthly meeting on the 6th inst. of the Hastings Town Council, the Corporation, in conjunction with that of Ramsgate, adopted the following memorial to the Queen:—"To the Queen's Most Excellent Majesty,—May it please your Majesty—We, the Town Council of the borough of Hastings, desire most respectfully to approach your Majesty, and to represent the great importance of electric communication between the lightships of the Goodwin Sands and the shore, and also between the 'Sovereign' lightship and Eastbourne, being carried out as speedily as possible. The recent sad disaster to the German emigrant ship off Dover has deeply impressed us with the dangers attending the navigation along this perilous coast and crowded seaway, and we would respectfully submit that the proposals we are now advocating would materially lessen the dangers, and prevent in a great measure the sad loss of life at sea to which our attention is so frequently and painfully directed. We venture to bring the matter before your Majesty thus earnestly, well knowing your Majesty's deep and constant sympathy with all classes of your Majesty's subjects, and your Majesty's anxiety to alleviate the sufferings of the distressed."

Bournemouth.—A scheme has been set on foot at Bournemouth for the utilisation of the waste heat of the furnaces of the refuse destructor employed by the Town Commissioners for the supply of electric light. Mr. W. Lynd, in a paper communicated to a local journal, estimates that 30 horse-power will be available from this source. A report has also been prepared for presentation to the Commissioners by Mr. G. R. Andrews, the town surveyor. It is proposed to lay down engines and dynamos for the direct supply of twenty-five 3,000 candle-power arcs, to utilise the power during the day-time to charge accumulators for the supply of incandescent lamps. We understand that the E. P. S. Company are preparing an estimate for the latter portion of this scheme. It further appears that the Town Commissioners have recently ordered two 9 horse-power gas engines for pumping sea water to supply the street water-carts, and as these engines will usually be available for at least 12 hours per day in the summer and much longer in the winter, it is proposed as an alternative scheme to employ them for the same purpose. Mr. Lynd, who seems to have taken up the question with the utmost enthusiasm, concludes his paper with some excellent advice as to the necessity for having the work, if done at all, done thoroughly well, and to remember that the lowest tender is not always the most satisfactory.

The Electrical Distribution of Time.—In a paper recently read before the Paris Académie des Sciences M. Cornu has shown analytically that to obtain synchronism in a vibrating system the necessary and sufficient condition is that the free motion of the system shall be a damped vibration, and has also pointed out that the stable condition is obtained more rapidly the greater the amount of the damping. To carry out this in practice it is necessary, if two pendulums are to vibrate synchronously, that they should experience an impulse in one direction, and a retardation in the opposite sense in rigorously the same way. This M. Cornu obtains by fixing a permanent magnet to the lower extremity of the pendulum, the magnetic axis being perpendicular to the axis of the pendulum. An electro-magnet, with open circuit, is fixed on one side of the pendulum, and attracts it at each oscillation. On the other side is placed another electro-magnet, with a closed circuit, which acts simply as a damper and checks each swing. In this way perfect synchronism can be obtained between clocks a very considerable distance apart, which, indeed, is only limited by the length of line at which the retardation of the current from self-induction becomes sensible. Clocks constructed on this principle for the Geographical Department of the French War Office have been successfully synchronised over a distance of forty miles of a defective telegraph line.

Chelsea.—Rival Electric Light Companies.—At the last meeting of the Chelsea Vestry, the surveyor said he had received a letter from the Chelsea Electric Supply Company (Limited), and had been handed a letter which Mr. Mossop had received from General Webber, and his answer thereto. He reported that the point of this correspondence practically is as follows:—"That the Vestry is not in a position to grant the Cadogan Electric Light Company leave to place wires in, over, across, or along any street in Chelsea, because of the monopoly held by the Chelsea Electricity Supply Company. The latter company has appealed to the Board of Trade in support of their contention. As the interests of the Cadogan Electric Light Company are more affected than those of the Vestry, it may be that they would prefer to be directly represented at the hearing of the appeal. He therefore recommended the Vestry to (*a*) refer the letter to the Electric Lighting Committee, with power to act, and (*b*) to appear before the Board of Trade to defend the action of the Vestry, and (*c*) also with power to confer with the Cadogan Electric Light Company, and to take any steps with them in this matter as the committee shall decide.—Mr. Mossop moved the adoption of the report.—The Hon. C. Dillon seconded the motion. The Vestry were always thankful to Mr. Mossop for his action in the electric light matter, and they were very fortunate to have so able a man as Mr. Mossop to take an interest in this question, and anything he did the Board would agree to.—Mr. H. Young supported the motion. He thought the Vestry should be glad they could not agree to a monopoly; for his part he should like to see a little competition, for then they would have a chance of getting electric light cheap.—The motion was carried.

Automatic Danger Signal for Railways.—By an arrangement devised by Mr. Drummond, the locomotive superintendent of the Caledonian Railway, the use of fog signals on railways may be dispensed with. An angle bar is placed inside the rail, the one end being fixed to a stud, while the other is raised into position by a lever, worked at the same time as the arm of the signal when placed at danger, or lowered in the same manner when the signal is placed at "clear." On the engine of a passenger train is placed a lever, and the moment that lever comes in contact with the angle bar inside the rail at the signal it disengages another lever connected to a vertical rod, which is put in motion by a spring, and this puts on the continuous brake and stops the train. It requires no action on the part of the driver, as he has no power over the action of the lever. The moment his train stops, the driver knows there is danger ahead, and he waits for information before he proceeds. The apparatus can be applied to any continuous brake, and can therefore be used on all our railway systems without delay. In the case of a mineral or goods train on which there is no continuous brake, the lever is connected with an electric bell, which is rung at once and continues to ring till the lever is again put into gear. The ringing of the bell warns the driver that the signal is against him, and he at once shuts off steam and applies the brake and brings his train to a standstill. A very similar arrangement was brought out some twelve months ago by the station-master at Wimbledon, on the London and South Western Railway, but we have not heard whether it has been practically employed.

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THE RISE AND PROGRESS OF TELEPHONY IN THE UNITED KINGDOM.

(Continued from page 50.)

In our last chapter we completed the story of the successful defence of the Bell patents in the case of the United Telephone Company *v.* Harrison, Cox-Walker and Co. We have now to turn to the Edison patent, upon which the plaintiffs claimed the exclusive right to the employment of transmitters combining a diaphragm with the use of carbon. It was in delivering judgment upon this point that Mr. Justice Fry laid down the famous judicial definition of a diaphragm as "something which separates something from something else," a definition which, however otherwise unobjectionable, manifestly embraces, jointly and severally, the sum total of the material objects of the universe.

The Hunnings transmitter, which the plantiffs complained of as an infringement, has been already fully described in the course of these papers (see *Electrician*, August 26th, 1887, p. 338), where also we have already considered its relation both to the discovery of Hughes and to Edison's inventions. At this point we shall therefore confine ourselves to a brief recapitulation of the arguments set forth at the trial for and against the view that the instrument constituted an infringement of the Edison patent. Our readers will recollect that the Hunnings transmitter consisted of carbon in the form of powder loosely enclosed between two metallic plates.

In order fully to understand the position it is necessary to recognise the fact that Edison's claims were essentially for a *combination* of known parts. He did not, for instance, claim the use of carbon in order to vary the resistance of the circuit by its compression, for Clerac had already employed a tube filled with carbon, which could be more or less compressed by a screw in order to obtain a continuous adjustment of resistance. Nor did he claim the use of a method whereby the resistance of a closed circuit could be continuously varied in accordance with the variations of the sound waves, for Graham Bell had done this with more or less success in 1876 by means of electrodes dipping to a variable extent into a conducting liquid. Nor, finally, did he claim the employment of a diaphragm *per se*, for according to the definition already quoted, which was propounded by a witness for the plaintiffs, and upheld by the judge, it is evident that it could not be denied that diaphragms had been employed by previous experimenters. The gist of Edison's claims lay, in fact, in the *combination* of a diaphragm with carbon electrodes in such a manner that the electrical resistance of the circuit through the electrodes varied continuously with the phases of the vibration of the diaphragm, the combination being for the purpose of transmitting articulate speech.

The defendants endeavoured, however, to set up a distinction between a variation in resistance due to changes of pressure upon the carbon and a variation due to an increase or diminution in the number of points in contact. Upon this question the evidence of Sir William Thomson clearly had great weight with the judge. Sir William stated in cross-examination that he was "strongly of opinion that the cause [operating in Edison's instrument] was the change of area of contact." This view had been strengthened by some experiments of his own. We may quote this passage from the evidence for the sake of its own intrinsic interest. "I experimented 25 years ago," said Sir William Thomson, "on copper and iron, and found exceedingly minute changes [in electrical resistance]—changes of a fraction per cent., changes comparable with the change of length of the wire. I have experimented upon the resistance of contact, which is the thing in question. It is carbon contact which is so notably effected by these changes. And I have experimented upon metals to find what the nature of the effect was upon which depended the peculiar quality of carbon in being greatly influenced by these changes of pressure. My opinion has long been that it is the difference between a contact of a mere point and contact over an area which makes so great a difference in the whole resistance. But if that difference depends at all in the conductivity of the resistance, it must be felt, though in a less degree, in metal. I have experimented on copper and brass. I experimented more particularly on copper—copper globes, or half globes, solid, and on a rigid copper plate; and I find that when carefully cleaned and pressed together I get a definite resistance between the two, tested by wires soldered to the two plates about two or three tenths of an inch from the small surface of contact. I find that when I apply pressure and increase the pressure I get a continually diminishing resistance; when I reduce the pressure I get a continually increasing resistance. There is a difficulty in obtaining definite numerical results, but I have no doubt from what I have seen that the effect depends wholly on the area of the interface between the two; the effect would be greater than that in carbon [? greater *in* carbon] because of its semi-conductive power."

The witness was next asked whether the brass or tinfoil disc between which the carbon powder was placed in the Hunnings transmitter played any part save that of conducting the current to the carbon. Sir William replied that it also performed the function of conveying pressure to the carbon. The question touched the very core of the matter in dispute, and the value of the patent ultimately depended entirely upon the view taken by the Court upon this point. The following conversation ensued:—

Mr. HEMMING: Suppose you took that foil away, and only got the means of carrying the electricity into a heap of coke carbon, would not the instrument work just as well without the foil?—No; this would not work at all.

Look at this. You see two plates of brass, which are connected with two different poles of the battery?—Yes.

They are some little distance apart, and over the gap is a heap of our coke carbon?—Yes.

Do not you suppose that would speak?—I think very likely.

Just as well as ours?—I do not know whether as well or not.

That is the nearest approach we can make to a Hunnings in principle, with something which shall perform the conducting functions, but without anything which anybody can pretend to be a tympanum. The current goes from one brass plate to the other through the little fragments of charcoal, and of course there is a good deal of resistance in the passage. The amount of that resistance is varied, not by a tympan acting on the charcoal at all, but by the air waves themselves acting. The air waves themselves joggle the little bits of charcoal about and alter the number and nature of the points of contact and so alter the resistance. That is the way it must act in that, and what I am putting to Sir William is—

Mr. Justice FRY: You say this might speak although it has no tympanum?—Sir WILLIAM THOMSON: It has a tympan, my lord.

Where is the tympan?—The tympan is that large surface which you are looking straight at; the top surface of the wood and brass.

The joint?—The top surface of the wood and brass is put into a state of vibration. That increases and diminishes the pressure of every particle of carbon upon the metal. I tried an experiment which I very well remember. It was placing little two-legged or three-legged objects upon the sounding board of a piano, and when the piano was played they all danced. That is the telephone now in court, the result being due to the motion of the platform on which the whole stands.

Instead of there being a direct pressure by the coke or other surfaces above, this would operate by this board moving like the board of the piano and setting in motion the minute particles of carbon?—Yes, clearly, my lord, that board is the tympan.

Mr. HEMMING: I quite follow you, Sir William, and I will not ask you any more about that.

Other evidence in support of Sir William Thomson's view was adduced—notably that of Dr. John Hopkinson. In delivering judgment, Mr. Justice Fry dealt with this vital point as follows:—

"In Hunnings', the up-and-down motion produced by the voice is communicated through the foil to the particles directly; in Edison's, the up-and-down motion of the voice is translated into circular nodal ripples in the disc or tympan. This is re-translated, so to speak, to the centre, into an up-and-motion which is communicated to the cork, and which the cork communicates to the foil, and the foil to the air. The result appears to be that that action in Hunnings' is more accurate, because more direct. In Hunnings' case there is not that magnifying of the operation of the voice that takes place in the presence of the tympan or disc in Edison's. The Hunnings transmitter appears to me, therefore, to be an improvement on Edison's patent; but it may none the less be an infringement of it, and I have come to the conclusion that, like Edison's, it is the combination of a diaphragm vibrating with the voice, that being the platinum foil, with a tension regulator consisting of a semi-conductive

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resilient and compressible substance, and it is therefore within the scope of Edison's specification.

"It has been argued that Hunnings' transmitter acts on a different principle to Edison's, that the one demands compression and the other freedom of motion; that in the one the presence of the diaphragm is essential, and that in the other it is not; but the evidence, amongst others, of Prof. Dolbear, shows that the presence of the foil is essential or useful in both cases. In both cases it acts as an electrode, in both it requires extension in order that an electric current may pass through all parts of the substance which constitute the tension regulator; in both it keeps the enclosed substances in their places. Before passing from this subject, and considering the meaning of the word diaphragm, I think it not immaterial to observe that Mr. Hunnings, acting with the assistance of the patent agent, whose name he mentioned to us, in describing his own invention, described the top of the platinum foil as a vibrating diaphragm.

"That is exactly the conclusion which I have drawn, that the platinum foil is a vibrating diaphragm, and I have concluded that Edison described as the essential requisite of his invention the combination of a vibrating diaphragm with a tension regulator.

"The discovery Prof. Hughes made in 1878 that the vibrations produced by the voice might operate on a heap of particles directly and without the intervention of any diaphragm or tympan, or any such thing, has, in my opinion, suggested the argument that Hunnings' and Edison's transmitters operate on different principles; but not only is it the fact that the Hunnings transmitter is not used without the platinum foil, but it has not been shown that it can be so used with success, and according to the evidence of Prof. Silvanus Thompson, the same physical principle, namely, that of diminishing the resistance and increasing the current by the increase of contact from pressure, underlies the light of the tension regulator of Edison and the microphone of Hughes."

The Hunnings instrument was therefore held to be an infringement of Edison's specification.

The defendants, however, gained a temporary victory, the objection that the patent was invalid owing to the inclusion of the phonograph in the same specification being upheld. This, however, being a mere error on the part of the agent, the plaintiffs were very properly permitted to disclaim that portion of the specification, and the patent has ever since been fully sustained.

(To be continued.)

THE MENGES THERMO-MAGNETIC GENERATOR AND MOTOR.

We have received from M. Menges (of the Hague) a most interesting description of an apparatus on which he has been at work for some time past, with the object of generating electricity by the direct conversion of heat, or, as it might be more accurately described, by a more direct conversion than that of an ordinary dynamo. M. Menges' apparatus depends, like that of Edison, upon the fact that the magnetic metals lose their magnetic permeability at a certain temperature. It differs greatly, however, from its predecessor in important points, especially in the fact that it does not require the aid of any external source of motive power.

In Edison's pyro-magnetic dynamo it will be remembered that it is necessary to provide some small amount of motive power from an extraneous source in order to revolve the shield by which the heat is alternately directed on one half or the other of the armature cores. M. Menges' apparatus is, on the contrary, wholly automatic.

We proceed to give a free translation of the description furnished us by the inventor.

In attempting to employ the thermo-magnetic properties of iron or nickel in the construction of machines for the generation of electricity upon an industrial scale, we are met with the difficulty that the heating and cooling of large masses of metal not only involves great loss of heat but also requires much time; hence to obtain a useful effect of any importance it would appear necessary to employ machines of dimensions altogether impracticable. By the device and method of construction now to be explained this difficulty has, however, been completely overcome.

The action of a magnetic pole diminishes so rapidly with the increase of distance that it may suffice to remove the armature to a distance relatively small compared with its own dimensions, or with those of the magnet, in order to reduce

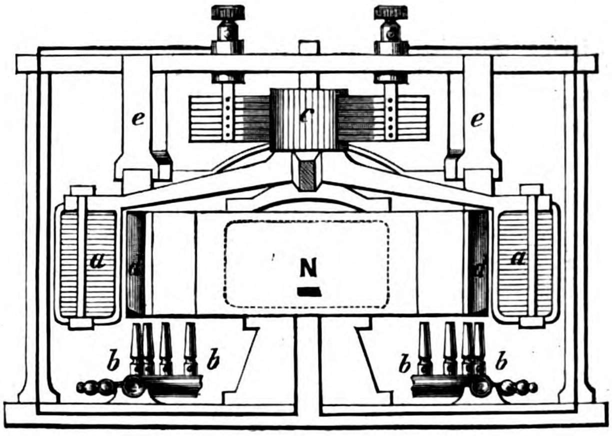

FIG. 1.

the action to a negligible value. But if, the magnet N S and the armature A being at a certain distance, we bring between them a piece of iron or nickel, *d*, then the magnetic force upon A is immediately and very considerably increased. In modern language, the resistance of the magnetic circuit has been reduced by the introduction of a better magnetic conductor, and the number of lines of force passing through A is proportionately increased. The mass of the piece *d* may, moreover be relatively small compared with that of N S and A. If *d* be

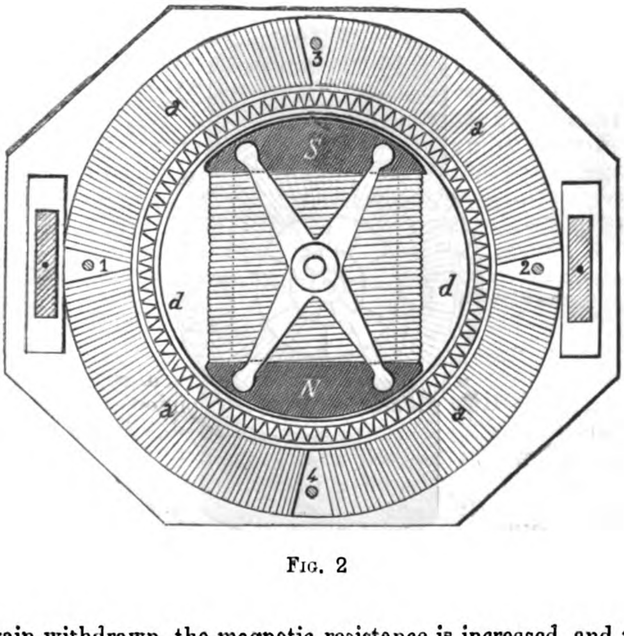

FIG. 2

again withdrawn, the magnetic resistance is increased, and the lines through A are again a minimum.

Now, it is evident that we can also obtain the same effect by sufficiently heating and cooling the intermediate piece *d*; and again, with a broad field we can alter the distribution of the lines at will by heating or cooling one side of this piece or the other. For this reason we will call the piece *d* the *thermo-magnetic distributor*, or, briefly, the distributor.

We will now describe the manner in which this principle

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has been realised in the practical construction of both a thermo-magnetic generator and motor.

Fig. 1 shows an elevation and part section of one of the arrangements employed. Fig. 2 is a plan of the same machine (in the latter the ring *a a* appearing on a higher plane than it actually occupies).

N S is an electro-magnet, *a a* the armature, wound as a Gramme ring, and fixed to a frame with four arms, which can turn freely upon a pivot midway between the poles. The cross arms of the frame are attached at 1, 2, 3, 4, Fig. 2. Between the magnets and the armature is placed the distributor *d d*, where it occupies an annular space open above and below. Both the magnets and the armature are coated on the sides facing the distributor with mica, or some other non-conductor of heat and electricity. The distributor is attached to and supported by the cross-arms, so that it turns with the armature.

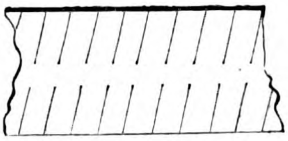

Fig. 3.

The distributor is composed of a riband of iron or nickel, bent into a continuous zig-zag. This form has the advantage of presenting, in the cool part of the distributor, an almost direct road for the lines of force between the poles and the armature, thus diminishing the magnetic resistance as far as possible. At the same time the Foucault currents are minimised. To the same end it is useful to slit the riband, as in Fig. 3; this also facilitates the folding into zig-zags.

The distributor is heated at two opposite points on a diameter by the burners *b b*, above which are the chimneys *e e*. The cooling of the alternate section is aided by the circulation of cold air, which is effected by means of the draught in the chimneys *e e*. At the points of lowest temperature a jet of air or water is maintained. The cross-arms are insulated with mica or asbestos at the points where they extend from the armature to the distributor.

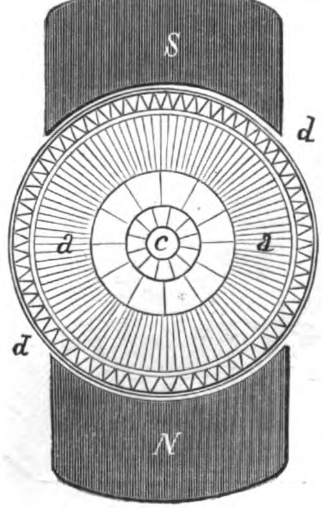

Fig. 4.

It will now be evident that while the distributor is entirely cool many of the lines of force pass from N to S without entering the armature core; but if heat is applied at the points 1 and 2 in the figure, so as to increase the magnetic resistance at these points, then a great portion of the lines will leave the distributor, and pass through the armature core. Under these conditions, so long as heat is applied at two points equidistant from N and S, we might, if we so pleased, cause the armature to be rotated by an external source of power, and we should then have an E.M.F. generated in the armature coils—that is to say, the machine would work as an ordinary dynamo, and the power expended in driving the armature would be proportionate to the output.

Suppose next that the points of heating, and with them the alternate points of cooling 90deg. apart, are shifted round about 45deg., so that the two hot regions are no longer symmetrically situated in respect to each pole of the field. The distribution of the magnetisation has therefore become unsymmetrical, and the iron core is no longer in equilibrium in the magnetic field. We have, in fact, the conditions of Schwedoff's experiment upon a larger scale, and if the forces are sufficient to overcome the frictional resistance a rotation of the ring ensues in the endeavour to restore equilibrium. The regions of heating and cooling being fixed in space, this rotation is continuous so long as the difference of temperature is maintained. The ring in rotating carries with it the armature coils, and of course an E.M.F. is generated in the same way as if the motive power came from an external source. In this respect the machine therefore resembles a motor-generator, and the rotation is entirely automatic.

The armature coils are connected with a commutator in the usual way, and the field may, of course, be excited either in shunt or in series. M. Menges says that the residual magnetisation is sufficient in his machine to start the rotation by itself.

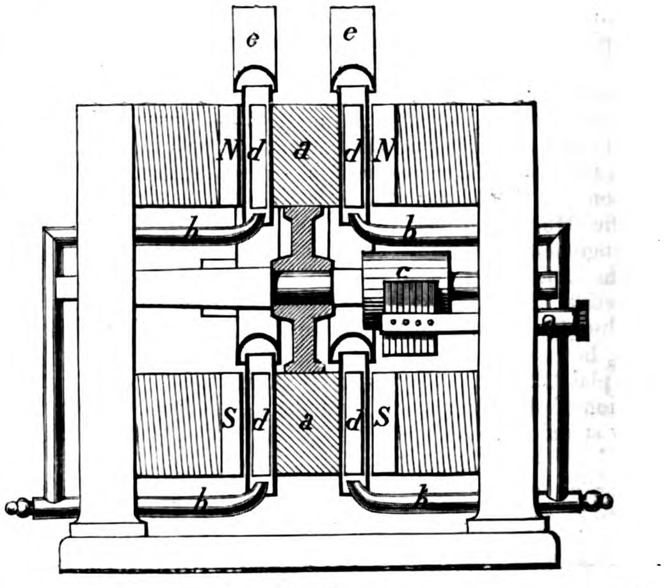

Fig. 5.

When the machine is to be used as a motor it is evident that the windings on the armature core need only be sufficient to supply current to excite the field, or by the use of permanent magnets they may be dispensed with altogether.

M. Menges has further designed a large number of variations on the original type, varying the arrangement of the several parts, and employing armatures and fields of many different types, such as are already in use for dynamos.

In Fig. 4 a machine is represented in which the field is external to the armature.

In Fig. 5 we have a thermo-magnetic generator, which corresponds to the disc machine in dynamos. Similar parts are indicated by the same letters in each of these figures, so that no further detailed description is necessary.

In another modification M. Menges proposes to rotate the burners and leave the armature and distributor at rest. But in this case it is evident that the E.M.F. produced would be much less, because the magnetisation of the core would only undergo a variation of intensity, and would nowhere be reversed, except, perhaps, just in front of the poles. In machines modelled on the Brush type it is evident that the distributor need not be continuous.

Enough has, however, been said to indicate the extent of the field upon which the principle may be applied.

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SOME ENGLISH CENTRAL LIGHTING STATIONS.

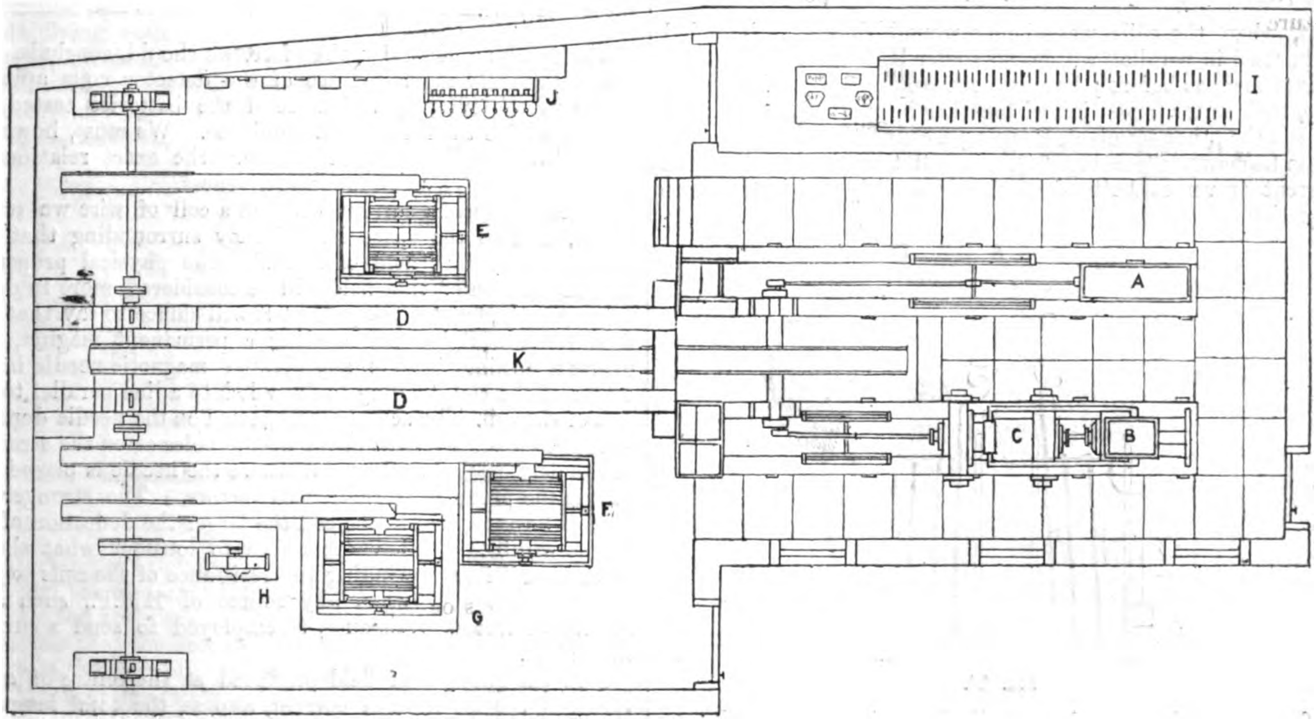
III.—SHEFFIELD.

The accompanying illustration shows the plan of the central station of the Sheffield Electric Light and Power Company. The company commenced operations in November, 1886, with a 40 arc-light Thomson-Houston 6-ampere plant. The results were sufficiently encouraging to warrant the early enlargement of the station and the introduction of three 50 arc-light 10-ampere Thomson-Houston machines. Good prices are realised for the lights, which are readily taken up by consumers. Three consumers take 30 lights between them, and the lights are used in stores, clothiers', drapers' and hosiers', billiard rooms, cafés, hotels, music saloons, theatres, &c., so that further developments may be looked for at no distant date.

It is needless to add any details as to the working of this installation, the Thomson-Houston system being so well known to our readers. We therefore simply remark that in the hands of Messrs. Tasker the result obtained is fully up to the usual high standard of excellence of this system.

The introduction of incandescent lighting by secondary generators is also contemplated. A Phœnix dynamo is employed to charge storage batteries for the supply of incandescent lights to the offices of the company and adjoining works and premises.

We may add that the same firm has put down a fair number of isolated plants in the Sheffield district. Of these the most important is that now in use during the building of a small-pox hospital which has unhappily become a necessity. The building is being erected in an out-of-the-way district called Redmires, on the borders of the Derbyshire moors, and is to be finished within thirty days of the time of commencement. The work is therefore being carried on day and night without intermission by the aid of a Thomson-Houston 40-light plant.



PLAN OF SHEFFIELD ELECTRIC LIGHTING STATION.

TABLE OF REFERENCE.

A,	High pressure cylinder, 13in. diam. by 4ft. stroke.	E F G H,	Dynamos.
B,	Low ,, ,, 25in. ,, 2ft. 9in. ,,	I,	Storage batteries.
C,	Air pump condenser.	J,	Switch boards.
D D,	Beams supporting main bearings for counter shaft.	K	Driving belt.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

(Continued from page 215.)

CHAPTER VI.—*Current Indicators (continued).*

59. Now if we intend the coils to be joined electrically in series a little thought will show that the coils must be wound

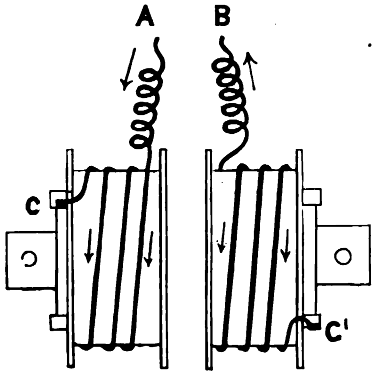


FIG. 22.

opposite ways. Referring to Fig. 22, each coil when its winding was commenced had the underneath end soldered at C C' to the bobbin, the winding on each coil then being in opposite ways. If now a current is sent, say from terminal A to B, it will flow round the two coils in series and in the same direction through each, the points C C' being connected through the brass work.

If we required to reduce the resistance of the coils, still utilising both, we should connect them in parallel or multiple arc, their combined resistance being then reduced to one quarter

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(para. 41). To do this we could not alter the connections of the coils in Fig. 22 without having wires between them to connect them electrically. The inside end of either coil, say that end attached to C_1, would have to be removed and connected to the outside end of the other coil, a short wire, *w*, being used if the inside end exposed was too short (see Fig. 23). Then the outside end of the first named coil would have a wire connecting it to the brass work at any convenient point, say at C_2. Now, passing a current from A to B, it is seen to flow through both coils in "parallel," and in the same direction through each, and meet at the brass work C C_2, whence it passes to B.

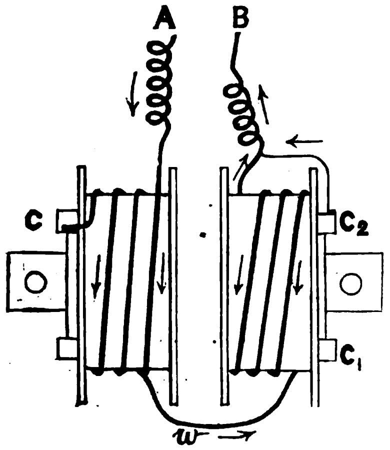

Fig. 23.

If, when the coils were being wound, they were intended to be used in parallel, we should solder both inner ends to the brass frame, as before; but the coils would be wound the *same way*, their outer ends joined together forming one terminal, A, and the other terminal, B, being a connection simply to the brass framework (see Fig. 24). It will then be seen that the current traverses both sides simultaneously and in the same direction.

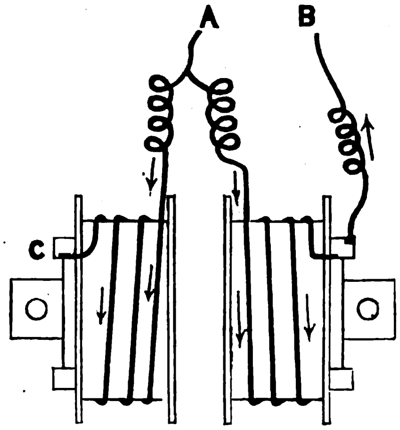

Fig. 24.

60. The resistance of the coils is an important point as regards the sensitiveness of the instrument when we come to employ it with batteries of different resistance. For instance, any number of similar voltaic cells connected in series would give the same deflection on the detector as a single one of those cells if their internal resistance was high and the resistance of the instrument coils very low. No idea could be formed, therefore, from such a test as to the number of cells connected together.

To take an example—a Minotto cell (see para. 17) measures when in actual work about 1 volt E.M.F., and 20ω internal resistance. Now, if we connect this to a low-resistance detector—say $\frac{1}{10}$ω—the current through the instrument will be $\frac{1}{20 \cdot 1}$ ampere, or 49·7 milliamperes; and if we connect ten of those cells in series the current will be $\frac{10}{200 \cdot 1}$ ampere, or 49·9 milliamperes. Now, as the current is practically the same in the two cases, the deflections on the instrument will be equal, and therefore we should be unable to tell from the indication of the instrument alone what battery power was on.

If, on the other hand, the resistance of the coils was higher, say 100ω, we should get with one cell $\frac{1}{20+100}$ ampere, or 8·3 milliamperes, and with ten cells in series $\frac{10}{200+100}$ ampere, or 33 milliamperes—*i.e.*, about four times as much current, and therefore a sufficient difference in the deflections.

Similarly, if low-resistance batteries connected in multiple arc were tested with a high-resistance detector, the deflection would be the same for any number of cells. As an example, take large size bichromate cells which will measure about 2 volts E.M.F., and 1ω resistance per cell, and let the detector coils measure 100ω. One cell connected to the instrument would give $\frac{2}{1+100}$ ampere, or 19·8 milliamperes; and ten cells in multiple arc would give $\frac{2}{0 \cdot 1+100}$ amperes, or 19·9 milliamperes, and therefore there would be no difference in the deflection.

On the other hand, if we emply a low-resistance detector, say one of $\frac{1}{10}$ω, one cell would give $\frac{2}{1+0 \cdot 1} = 1 \cdot 82$ ampere, and ten cells in multiple arc $\frac{2}{0 \cdot 1+0 \cdot 1} = \frac{2}{0 \cdot 2} = 10$ amperes, giving considerable difference in the currents, and therefore in the deflections.

61. Speaking generally, therefore, we should conclude that the more nearly the resistance of the detector coils approximated to the internal resistance of the batteries tested, the more sensitive the instrument would be. We must, however, go further than this, and see what are the exact relations of the resistances for maximum sensitiveness.

When we pass a current through a coil of wire we set up inside, and in the space immediately surrounding that coil, what is termed a "field of force." The physical properties and delineation of this field will be considered more in detail subsequently, but for the present it will suffice to say that this field resembles that surrounding a permanent magnet, and exerts a turning force on any pivoted magnetic needle in the centre of the coil, tending to draw it into a line parallel to the axis of the coil. The actual *force* exerted on the needle depends as much on the strength of the needle poles as on the strength of the field created at the point where the needle is placed—in fact, is the product of these two factors. The stronger the field of force created in the coil the larger the deflection of the needle will be. We have therefore to consider what should be the conditions of winding and resistance of the coils to give the strongest field when any source of E.M.F., such as a battery of known resistance, is employed to send a current through it.

Now the strength of field produced at the centre of a coil varies as the strength of current, also as the total length of wire wound on, and inversely as the square of the mean distance of the wire from the needle, or if the coil is circular and the needle suspended at its centre, inversely as the square of the mean radius.

62. Suppose now that the size of the bobbins and the space to be occupied by the wire when wound on has been fixed upon; then the strength of magnetic field of the coils will vary simply as the product of the current through them and the square root of their resistance. The latter will be clear on considering that for a given weight or volume of wire the resistance is proportional to the square of the length. As an example of this, if we have two lengths, A and B, of different sized wire, B being ten times as long as A, but weighing exactly the same, it is clear that the sectional area of B must be $\frac{1}{10}$ that of A. Since B is ten times the length, its resistance would also be ten times that of A if it was of the same size; but since it is only

$\frac{1}{10}$ the area of A, its resistance is increased tenfold more, and therefore B measures 100 times the resistance of A—in other words, the resistance varies as the square of the length when the weight or volume is constant or conversely, the length varies as the square root of the resistance for a given weight.

63. We have then, as above, the field of the coil proportional to

current × length of wire, for which we may write

$$\frac{\sqrt{\text{resistance of coil}}}{\text{sum of resistance of circuit,}}$$

the current being inversely proportional to the total resistance of the circuit (viz., battery, leading-wires, and detector coil), with a constant E.M.F. This expression for the field can be easily shown mathematically to become a maximum when the resistance of the coil is equal to the battery and leading-wires, but it can be shown equally as well graphically without the aid of mathematics by the plotting of a curve from a few worked-out values. For instance, let us see how the field varies for different resistances of the detector coil when the total resistance *outside* the detector is 100ω.

Taking the resistance of coil as 9ω the field will be

$$\frac{\sqrt{9}}{100+9} = \cdot 0275,$$

and taking it successively as 49, 81, 100, 121, 225, 324, 400, and 484 (these numbers having simple square roots), we find the field becomes respectively ·047, ·0497, ·050, ·0497, ·046, ·0424, ·040, ·0376. These numbers are not in any particular units; they simply give the *relative* strengths of field. Multiplying each by some large number, say 500, will not alter their relation to each other, and will give us whole numbers instead of fractions, which is more convenient for plotting the curve. They will then become respectively 13·7, 23·5, 24·8, 25, 24·8, 23, 21·2, 20, and 18·8.

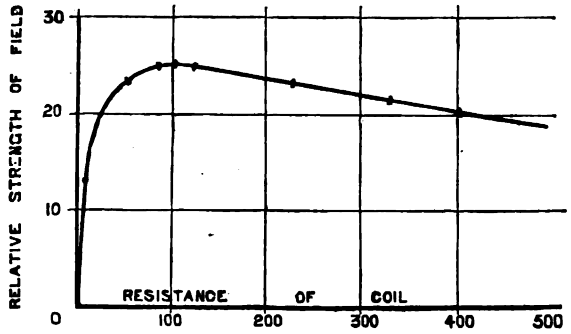

FIG. 25.

Marking off these values on the vertical ordinate (see Fig. 25) and the corresponding resistances given to the detector coil on the horizontal ordinate, we get the curve shown, which indicates that the best resistance for the coil is 100ω, *i.e.*, the same as the resistance of the rest of the circuit.

The curve shows also that if the actual resistance is any given fraction of the best resistance, say $\frac{1}{4}$, the field is the same as with the same multiple of it, viz., four times, both of which in this case give a field of 20. Or a 10ω coil detector would give the same deflection as one wound to 1,000ω for the same size of coil, but the field would only be (by reference to the curve) $\frac{15}{25}$, or $\frac{3}{5}$ of the maximum.

The above figures are all supposing 100ω in the circuit besides the instrument coil, but the curve will necessarily be of the same shape for any resistance taken, and will always show the field, and therefore the deflection, to be greatest when the coil (of given size and given weight of wire) is equal in resistance to the rest of the circuit.

64. For telegraph work, where comparatively high resistance batteries and instruments are met with, the resistance in a detector circuit when used for a battery or line test is more frequently over 100ω than under; they are therefore mostly used from about 200 to 500 ohms. But occasionally much lower resistance batteries require testing, such, for instance, as Thomson's tray cells or Fuller's bichromate cells, when a lower resistance coil, say of 5 or 10ω, will be more sensitive. Some detectors are wound with two coils of widely different resistances for this purpose.

65. A portable detector, the size of an ordinary watch, has recently been brought out by Messrs. P. Jolin and Co., of Bristol, which is wound with two coils, one of fine wire measuring 200·6ω, and the other of thick wire being 0·65ω. There are two bobbins which are first wound with the fine wire coil, the underneath end of the wire being soldered to the frame, and the upper end attached to one terminal, marked Z (see Fig. 26). To use this high resistance coil alone, therefore, the battery wires must be connected, one to the outside case of the detector, and the other to terminal Z, the winding being so arranged that the needle points towards Z when it is connected to the zinc pole. The thick wire coil is wound on next, one end being soldered to the brass bobbins as before, and the free end taken to the other terminal. If we connect the battery wires then between this terminal and the case the thick wire coil alone is in circuit. It would really only be the low-resistance coil that we should require to use alone; when the high-resistance coil was required we should use both coils

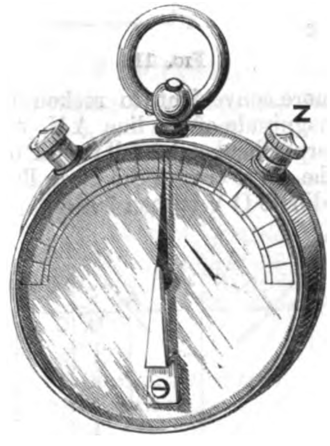

FIG. 26.

in series by connecting the battery to the two terminals, by which we should get the advantage of the extra turns of wire and an inappreciable increase in resistance.

(To be continued.)

NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

(Continued from page 30.)

In the last notes explanation was made of the analysis of any single valued continuous function into a series of simple harmonic functions. To simplify language we shall in future speak of a curve whose equation is of the form $y = A \sin x$ as a *simple periodic curve*, and if such curve graphically represents the continuous variation of the flow of electricity past any section of a conductor, or the fluctuation of electromotive force in any circuit, we shall speak of such as a *simple periodic current* or a *simple periodic E.M.F.*

Any other mode of variation of these quantities which, graphically represented, would be a single valued curve repeating the same form, will be spoken of as a complex-periodic curve, current, or E.M.F., and, by the foregoing analysis, a complex periodic function can be analysed into a sum of simple periodic functions.

The following method affords a very easy means of drawing a simple periodic curve. Take a cylinder or tube of pasteboard (see Fig. 11) and cut it through obliquely. The section of this cylindrical tube by an oblique plane will be an ellipse. Slit the tube open along the line A B and unfold it. Lay it down on another sheet of paper and draw a pencil line guided

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by the curved edge A Y Y′. Draw a dotted line, X X′, so that its vertical distance below the highest point Y on the curve is equal to its vertical distance above the points A and Y′, or make O Y equal to A X. Then move this cardboard template forward through a distance equal to its own width, and draw another piece of curve repeating the first and similarly placed (see Fig. 12).

The resulting curve is a simple periodic or simple sine curve. The distance X X′ equal to the circumference of the tube or to the width of the template is called the *wave length.* The distance O Y of the highest point above the mean line is called the *amplitude.* If the bottom edge of the template is divided into 360 parts or units, then the distance O M, measured in such units, of the foot of the perpendicular let fall from any point P from O is called the *phase* of the point P.

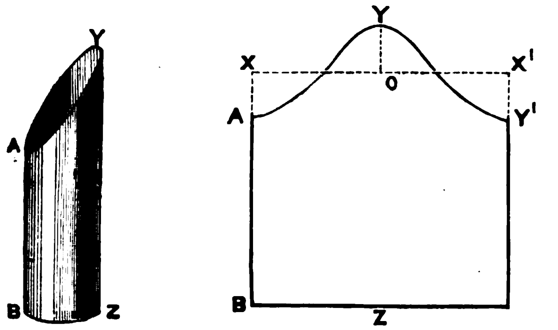

Fig. 11.

It is perhaps more convenient to reckon the phase of the point P by the magnitude of the line A N, or the distance of the foot of the perpendicular, let fall from P on X X′ from the point A, where the curve crosses the mean line. The phase of the maximum ordinate O Y is then 90deg.

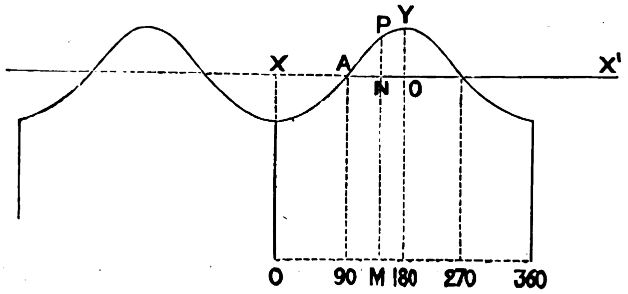

Fig. 12.

Let Fig. 13 represent the semi-wave of a simple periodic curve, we shall proceed to prove some geometric properties of such a curve. Considering this curve as bounding an area of which the other including line is the datum line X X′, we shall first find the value of the mean ordinate. Let X X′ be divided into equal and very small intervals, such as N N′, of which the length is dx, and let X N be called x. Assume as a unit of length the radius of the cylinder, of which X X′ is the semi-circumference. At each of these small elements raise ordinates, such as P N, to touch the curve. We require to find the mean value of all these equi-spaced ordinates when they are infinitely close. The mean value of a number of

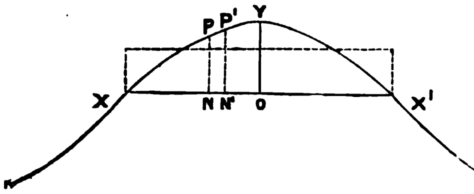

Fig. 13.

things is the sum of them divided by their number. If y denote the length of one such ordinate P N, and Σy the sum of all such ordinates when ruled at n equal and exceedingly small intervals, each of length dx, then the average value of these infinitely numerous ordinates is

$$\frac{\Sigma y}{n}, \quad \text{or} \quad \frac{dx\,\Sigma y}{n\,dx}, \quad \text{or} \quad \frac{\Sigma y\,dx}{n\,dx};$$

but the sum of all such quantities is $y\,dx$, or P N . N N′, is the sum of all the areas of the little rectangular slips into which these infinitely numerous ordinates divide the area bounded by the curve and X X′ and $n\,dx$ is the length X X′, hence we have

$$\text{mean ordinate} = \frac{\text{area X Y X}'}{\text{length X X}'}.$$

The area X Y X′ is obtained by integrating the equation to the curve. Calling the maximum ordinate O Y A, and the distance X N x, the unit being the radius of the cylinder of which X X′ is the semi-circumference, we have

$$y = A \sin x$$

as the equation to the curve, and

$$\int y\,dx, \qquad \text{or } A\int \sin x\,dx$$

between the limits O and π is the area of the curve.

But $$A\int \sin x\,dx = -A \cos x,$$

and this between the limits O and π is equal to 2 A. On the same scale the length

$$X X' = \pi.$$

Hence, the average value of the infinitely numerous and equi-spaced ordinates is $\frac{2A}{\pi}$, or the average ordinate $= \frac{2}{\pi}$ × the maximum ordinate.

The value of $$\frac{2}{\pi} = \cdot 6369.$$

Hence, average value of the ordinate of a simple periodic curve, or the true mean ordinate is ·6369 of the maximum ordinate, and therefore if a current or an electromotive force varies according to a simple periodic law, the true mean current or the true mean E.M.F. is ·6369 of the maximum current or E.M.F. during the phase.

We have here made use of one simple integration, and it is generally easier to master the elements of the infinitesimal calculus than to construct or follow proofs which aim at avoiding its use. We shall, however, indicate how the value of this mean ordinate may be found from first principles. If we call the length of the base line X X′ l, and divide it into n, equal and very small parts of length δx, then $n\,\delta x = l$. Erect at each interval an ordinate whose height is y, then the equation to the curve is $y = A \sin \frac{\pi}{l} x$, where x is as before the distance X N. The mean value M of the ordinate is the sum of all the values of the ordinates divided by their number, or is equal to $$\frac{1}{n}(y_1 + y_2 + y_3 + \&c.)$$

$$\therefore M = \frac{1}{n} A \left\{ \sin O + \sin \frac{\pi}{l}\,\delta x + \sin \frac{\pi}{l}\,2\,\delta x + \ldots \right.$$
$$\left. + \sin\left(\frac{\pi}{l}\,\overline{n-1}\,\delta x\right)\right\}$$

The sum of the sine terms in the bracket is known by trigonometry to be equal to

$$\frac{\sin\left(\frac{\overline{n-1}}{2}\,\frac{\pi}{l}\,\delta x\right) \sin \frac{n}{2}\frac{\pi}{l}\,\delta x}{\sin \frac{\pi}{l}\frac{\delta x}{2}}.$$

Hence $$M = \frac{A}{n}\left\{\frac{\sin\left(\frac{n-1}{2}\,\frac{\pi}{l}\,\delta x\right) \sin \frac{n}{2}\frac{\pi}{l}\,\delta x}{\sin \frac{\pi}{l}\frac{\delta x}{2}}\right\}$$

which may be otherwise written—

$$M = \frac{A}{n\,\delta x}\,\frac{l}{\pi}\,\frac{\frac{\pi\,\delta x}{l}}{\sin \frac{\pi}{l}\frac{\delta x}{2}} \left\{ \sin\left(\frac{n\,\pi\,\delta x}{2\,l} - \frac{\pi\,\delta x}{2\,l}\right) \sin \frac{n\,\pi\,\delta x}{2\,l} \right\}$$

When n becomes infinite, and δx becomes zero, $n\,\delta x$ remains still equal to l; hence in the above expression in this case reduces to the following:—

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$$M = \frac{A}{\pi} . 2 . \sin^2 \frac{\pi}{2} . = \frac{2}{\pi} A.$$

for the value of $\frac{h}{\sin \frac{h}{2}}$ is 2 when h becomes zero.

Accordingly the mean value of the ordinates when they are infinite in number and equi-spaced is $\frac{2}{\pi}$ times the magnitude of the maximum ordinate.

ERRATA.—In the previous article, Nov. 18, 1887, the reader is requested to make the following corrections :—In Fig. 8 the letters $M_1 M_2$ and $F_1 F_2$ should be interchanged, the upper pulleys being the fixed ones. In Fig. 9, lower diagram, the point B should be diametrically opposite to A, as they are the traces on a horizontal plane of the sides A C B D of the frame A B D C.

(To be continued.)

LEGAL INTELLIGENCE.

The Anglo-American Telegraph Company (Limited) v. La Compagnie Francaise du Telegraphe de Paris a New York.

This was an action brought in the Tribunal of Commerce of the Seine for the purpose of compelling performance by the French company (known as the Pouyer-Quertier, or P. Q. Company) of the pooling agreements made in 1880 and 1882 by them with the Anglo Company, the Direct Cable Company, the American Cable Company, and the Western Union Company. By these agreements all the companies agreed to put their gross receipts from transatlantic cable messages into a joint purse, and divide them in agreed proportions, the share of the French company being 16 per cent. The concession of the French company stipulates that the company shall not amalgamate or fuse their interests with any other Atlantic cable company without the express consent of the French Government in writing. When the first pooling agreement was made with the French company in 1880 they submitted a copy of it to M. Cochery, then Minister of Posts and Telegraphs, and asked for his consent to the agreement. After considerable delay M. Cochery told M. Pouyer-Quertier verbally that the agreement did not require his consent. Consequently the companies put the agreement into execution without the consent being obtained, and it had full execution to the knowledge of the French Government until 1882, when the Western Union Company's cables were brought into the pool and a fresh agreement (precisely similar as regards the fusion clause to that of 1880) was made. No application to the French Government for its consent to the agreement was considered necessary. This agreement was carried out by all parties up to 31st December, 1886, when, without warning or notice, the managing director of the French company wrote to the other companies that M. Granet, the Minister of Posts and Telegraphs, had notified him that the agreement of the French company with the other Atlantic Telegraph Companies was in contravention of their concession, and must be discontinued, and they consequently declared the agreements at an end as from that day. This sudden and startling action on the part of the French company was doubtless brought about by the change which a few months before had been made on the Direction of the French company. Count Dillon, the manager of the Commercial Cable Company, is reputed to have obtained control of the majority of the shares and turned out the old board, putting in a new set of directors assumed to represent in some sort the Commercial Company's views, especially as to raising the tariff, which then stood and still stands at 6d. per word. The Anglo-American Company commenced their action against the French company in the month of February, 1887, claiming performance of the agreements of 1880 and 1882, notwithstanding the alleged Ministerial decision of M. Granet, and 5,000fr. a day as damages until performance of the agreements was resumed, with 5,000fr. a day for every day elapsed since 31st December, 1886, when the agreement was broken.

The case came on for hearing before the Tribunal in Paris on the 12th December last, and was then ably argued by M. Ernest Caron for the Anglo-American Company, and by M. Liquereux for the French company. The argument lasted the whole day. M. Caron argued that M. Granet, as Minister of Posts and Telegraphs, had no right or power to annul the decision of his predecessor, M. Cochery; that the agreement did not require Government sanction ; that M. Granet's letter was not a binding judgment on the question ; that the French company ought to have appealed (as their concession enabled them to do) to the Council of the Prefecture of the Department of the Seine and to the Council of State against M. Granet's decision ; that until a proper and legal decision had been given against the validity of the agreement, the French company were bound to fulfil its conditions, and that they had not acted *bonâ fide* in putting an end to the agreement. M. Liquereux's defence for the French company was, in effect, that the agreement was unquestionably a fusion of interests, forbidden by the concession without the Government's written consent, and that all the parties to the agreement were so advised at the time by their lawyers ; that, although (as he submitted) M. Cochery had verbally said the agreement did not require the Government consent, this was not given in writing and was not binding on his successor ; that M. Granet had in exercise of his right decided that the agreement was contrary to the concession ; that the French company would forfeit their concession if they did not comply with the Minister's requirements—in short, that it was a case of *force majeure.*—The French company had no alternative but to denounce the agreement, and had only acted in protection of their own existence.

On the 9th January, 1888, the Tribunal pronounced its judgment, which is that the French company must resume performance of the agreement from the day of service of the judgment, under penalty of 5,000fr. (£200) a day for every day's delay until the expiration of one month, when the Court will adjudicate upon future damages, and that by way of damages for the past the French company shall pay to the Anglo Company 2,000fr. (£80) per day from the 31st December, 1886, until the date of the service of the judgment.

The amount of damages thus awarded to the Anglo-American Company is about £32,000.

MEETINGS OF SCIENTIFIC SOCIETIES.

(Week ending Thursday, 19th January.)

TO-DAY (FRIDAY), January 13th.

ASTRONOMICAL SOCIETY.

8 p.m. Meeting.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Supplemental Meeting for Students. Paper to be read— "Railway Engineering in British North America." By Mr. ROBERT J. MONEY, Stud. Inst. C.E.

TUESDAY, January 17th.

ROYAL INSTITUTION.

3 p.m. The first of ten Lectures on "Before and After Darwin." By Mr. GEO. J. ROMANES, M.A., &c.

SOCIETY OF ARTS.

8 p.m. Meeting of Foreign and Colonial Section. Paper, "The Colonies and Dependencies of the Netherlands and of Portugal." By Mr. A. J. R. TRENDELL, C.M.G.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed, "The Use and Testing of Open-Hearth Steel for Boiler Making." By the late HAMILTON GOODALL, A.M.I.C.E. Paper to be read (time permitting), "The Erection of the 'Jubilee' Bridge over the River Hooghly, on the line of the East Indian Railway." By Sir BRADFORD LESLIE, K.C.I.E., M.I.C.E.

WEDNESDAY, January 18th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper, "Methods of Taking Ballot." Three Papers by Messrs. JOHN LEIGHTON, JAMES WITHERS and JOHN IMRAY. The ATTORNEY-GENERAL, M.P., will preside.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting. Paper on "The Non-Instrumental Meteorology of England, Wales and Ireland, 1878-1885." By G. M. WHIPPLE, B.Sc., F.R.Met.Soc., F.R.A.S.

8 p.m. Annual General Meeting. The Report of the Council will be read, the Election of Officers and Council for the ensuing year will take place, and the President, Mr. W. ELLIS, F.R.A.S., will deliver his Address.

THURSDAY, January 19th.

CHEMICAL SOCIETY.

8 p.m. Meeting.

THE ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

3 p.m. Lecture on "The Walker School." By Mr. HUBERT HERKOMER, M.A., A.R.A.

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1887.

The Telephone.

THE UNITED TELEPHONE COMPANY.—This company, which is well known as the parent of many of the provincial companies, is essentially a metropolitan institution, and with the exception of its connection with Brighton has no trunk lines attached to its system. Down to the end of September last its subscribers in London numbered 4,596.

THE NATIONAL TELEPHONE COMPANY.—This large and important telephone company carries on business not only in Yorkshire, which is its head-quarters, but in Scotland as far as Inverness, as well as in the districts in England of which Whitehaven, Paisley, Wolverhampton, Hanley, Nottingham, and Birmingham are the centres; and in Ireland by the single town of Belfast. The total number of lines erected by this company down to the end of the year amounted to 8,478, made up of 7,301 exchange lines, and 1,177 private lines. 104 Exchanges are actually in operation, connected with which and through them to the trunk lines are 192 call offices. These trunk lines are connected largely with the Lancashire and Cheshire Exchange systems; and the town of Birmingham is about to be connected by trunk wires to the United system in London. Some idea may be formed of the progress made in the principal districts served by this company during the past year by the following figures:—The Glasgow district has now 1,537 exchange and 267 private wires, against 1,266 and 255 in 1886. In Edinburgh and Leith the exchange lines have increased from 367 to 407; and in Aberdeen from 493 to 527. The Leeds district has two additional Exchanges, the lines being increased from 436 to 544; and the private lines from 79 to 94. For Birmingham and its suburbs the exchange lines now number 538, their total in 1886 being only 475. The tariff is generally £10 per annum; but in the larger towns it is £15.

THE LANCASHIRE AND CHESHIRE COMPANY.—This important Telephone Exchange Company, whose head office is in Faulkner-street, Manchester, has now in active operation what may be described as three great circles of communication, the centres of which are respectively Manchester, Liverpool, and

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Blackburn. A similar district, embracing North Wales, and of which Wrexham will be the chief centre, is in process of formation, and it is intended ultimately to connect this with the trunk systems of the other districts. In the three Lancashire and Cheshire districts there are at present 35 towns in which Exchanges are fitted up; and of these no fewer than 29 are in trunk wire communication, not only with each other, but with some of the principal manufacturing towns of Yorkshire, including Leeds, Bradford, Halifax, Huddersfield, Wakefield, &c. The rates charged under these systems are in most cases £12 per annum; but in Manchester, Liverpool, and Birkenhead the charge is £20. These rates are for subscribers situated within a mile of the local centre, an additional charge of £7 per mile being made for distances beyond the first mile. For an extra annual charge of £12 subscribers to the Manchester and Liverpool city systems may have their residences connected; and at a proportionately lower rate the same privileges are extended to the smaller towns. Some idea of the extent to which these systems are being patronised may be gathered from the following figures:— In Manchester and Salford there are 1,706 subscribers—1,291 to the Exchange, and 415 private connections. To this may be added the public call offices, which now number 31. In Liverpool, not including Birkenhead, the figures are respectively 1,405, 500, and 25 call stations. In Blackburn there are 233 Exchange, and 38 private subscribers, and Preston numbers nearly as many. Most of the towns have two or three public call stations; Blackpool has 6, Southport 4, and Birkenhead 5. The grand total of subscribers at Christmas of the year just ended for the whole system covered by the Lancashire and Cheshire Company was 5,309, made up of 3,934 to the Exchanges and 1,375 for private lines. The call offices numbered 122. The income derived from the trunk wire and call office systems alone amounted last year to £7,500. The company's gross annual income is over £90,000. On 30th June last the company owned 7,250 miles of wire, about one-third of which is employed for intercommunication between towns. Fully 50 per cent. of the subscribers make regular use of the trunk wires, the number of calls reaching 3,000 per day, those for the purely local systems being 25,000.

Western Counties and South Wales Company.—From Bristol as a centre, the operations of this company extend to Cardiff, Hereford, Shrewsbury, and Malvern in one direction, and to Exeter, Torquay, and Plymouth in the other; while among the southern counties the towns of Bournemouth, Portsmouth, Southampton, and even Jersey are provided for. A comparison of the returns furnished for the two last years shows that the number of subscribers has increased from 1,318 at the end of 1886 to 1,995 in the first week of December, 1887. This last-mentioned total is made up of 1,536 subscribers to Exchanges, and 459 private line renters. The major part of the increase is due to extensions into fresh districts, or the rapid rise of business in towns where the service had been only recently installed in 1887. Bristol counts 489 customers and Plymouth 261. It should be remembered that this company, which is a subsidiary of the United, has been in existence only three years. A notable fact revealed in these returns is the amount of telephone business done in what may be called residential towns as distinguished from commercial. In Bournemouth and Torquay, for example, there are 170 and 131 subscribers respectively to the Exchanges; while in Cardiff there are only 68; and in Portsmouth and Swansea 132 and 134. Most of the service is day and night, at all events for all the business towns and for the holiday resorts, such as Torquay and Bournemouth. The rate for annual subscribers to the Exchange at Bristol and Clifton is £15, with some reduction if the agreement is for a term of years; but for all other places £12 is the usual charge. For an extra charge of £5 the subscriber can be connected to his private residence if within a quarter of a mile, a small extra covering distances beyond this when a term of 4 or 7 years is guaranteed. Although this company has been established but a comparatively short time it has already erected trunk lines which now exceed 900 miles. Bristol is connected with Bath, Gloucester, Newport, Cardiff, and Swansea; and Cardiff in turn is in connection telephonically with Aberdare, Merthyr, &c. Besides the places just mentioned Swansea speaks to Briton Ferry, Llanelly, and Landore; while Bournemouth and Poole, Torquay and Newton Abbot have trunk lines of their own united with the general system. The charges for using these long-distance lines are 6d., 9d., and 1s., according to distance, the conversation lasting three minutes. From Swansea to Bristol it is 1s., from Bristol to Bath it is only 6d. The company contemplate the erection of a trunk line to London, with which the whole of its system will then be in connection through its Exchanges. The gross rental for the year just ended is estimated at £20,000, of which sum £3,500 or more is payable to the Post Office and the "United," of which this company is a subsidiary, for royalties.

The South of England Company.—This company furnishes us with information only with respect to the towns of Eastbourne, Hastings, and St. Leonards. In the first-named place there are 70 Exchange and 23 private subscribers. At Hastings and St. Leonards they have 80 on the Exchange and 24 private connections. The tariff is exceptionally low—only £10 per annum. According to the *Bulletin International d'Electricité* the South of England Company embraces Great Yarmouth and its neighbourhood, as well as Oxford, Margate, and Maidstone, in its operations, and numbered last April 1,130 subscribers, trunk lines connecting Folkestone and Dover, Yarmouth and Norwich, Maidstone and Chatham, and Brighton and London.

The Northern District Company.—This company, whose centre of operations is at Sunderland, now possesses 576 Exchange wires, and lets 123 private wires. Of the Exchanges 13 are connected with trunk lines, of which the company has erected 1,144 miles, the Exchanges covering an additional 475 miles, and the private wires 295. The number of daily calls have increased from 1,437 in 1886 to 2,650 in 1887. It is intended to link this district to the National Company's system in Yorkshire, and thence to the Lancashire and Cheshire district.

The Sheffield Telephone Exchange.—This Exchange was inaugurated by private enterprise early in 1879, and as a private undertaking it has since been continued, enjoying a progressive and prosperous career. As a telephone exchange it is noteworthy on account of its independent and unique position in not being attached to, or subject to, any of the larger telephone companies, but working immediately under the license of the Postmaster-General. As Sheffield is situated in the very heart of the National Telephone district, it is not surprising that efforts have been made to bring about an amalgamation or working agreement between the two systems; but at present these efforts are not meeting with any encouragement on the side of the Sheffield Telephone Exchange, which apparently desires to maintain its complete independence. The Sheffield Exchange has more than 400 subscribers, as well as 120 private wires, and additional wires are continually being erected. Thirteen call offices are open to the general public on payment of a small fee. The adjacent town

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of Rotherham has for several years been in direct connection with the Sheffield Exchange, but a local Exchange has now been opened in Rotherham, which gives communication between the towns by means of trunk wires. The system is also being extended so as to reach Swinton, Mexbro', Wath, Wombwell, and Barnsley, thus uniting the whole of the South Yorkshire coalfields. There is a total length of 600 miles of wire on poles, and much of this passes through a heavy, acid-charged atmosphere. The rapid multiplication of the wires in the town and electrical considerations have rendered it necessary to employ copper wire, which besides being better adapted for telephonic transmission will also probably withstand the destructive effects of the Sheffield atmosphere. The operations of the proprietary have not been confined to Sheffield and the neighbourhood only. Private Telephone Exchanges have been erected for Her Majesty the Queen at Windsor, Balmoral and Osborne; for H.R.H. the Prince of Wales at Sandringham; for the Dukes of Norfolk, Devonshire and Newcastle, and for many other establishments in all parts of the country.

THE NEW TELEPHONE COMPANY.—This company, which was formed to work the patented valve telephone of Prof. S. P. THOMPSON, having established its right to an independent existence, is now actively pushing business by methods differing materially from those of the older companies. The New Telephone Company sells its instruments outright, as well as the wires, batteries, and materials necessary for maintaining them. Outside the field of the Exchanges which we have been describing there is undoubtedly room for installations of a private or local character, and it need not surprise us to learn that many large establishments, such as asylums, ironworks, collieries, and even railways have adopted the proprietary system devised by this company, whose instruments are said to be giving satisfaction wherever they are adopted.

THE TELEPHONE COMPANY OF IRELAND.—We have no later information relating to this company than the beginning of last year, when the number of subscribers in Dublin and Dundalk amounted to 915.

EUROPEAN SYSTEMS.—Of the general extension of the telephone system in Europe during the three years ended 1886 the following statistics have lately been compiled, and may here be interesting in connection with our survey of the progress of British telephony in 1887. No similar statistics are yet available relating to the American continent. The increase in the number of telephone wires was greatest in Switzerland, where it was 1,700 per cent. (from 2 in 1883 to 36 in 1886); Germany 333 per cent. (from 21 to 91); Austria, 267 per cent. (from 3 to 11); Russia, 233 per cent. (from 6 to 20); and Sweden, 200 per cent. (from 5 to 15). Belgium and Holland follow a long way behind, with an increase of only 50 per cent. (from 10 to 15). In Italy the number of telephone lines increased but 23 per cent. (from 13 to 16); in Great Britain 19 per cent. (from 75 to 89); and in France 11 per cent. (from 18 to 20). Germany had at the close of 1886 the largest number of telephone lines, 91; and Austria the smallest, 11. The increase in subscribers has been in proportion to the growth in the number of lines. Switzerland here also heads the list, subscribers having increased by 486 per cent. (from 835 in 1883 to 4,900 in 1886). In Germany the increase was 308 per cent. (from 3,613 to 14,733); Russia, 291 per cent. (from 1,451 to 5,280); Sweden, 267 per cent. (from 1,553 to 5,705); Austria, 248 per cent. (from 870 to 3,032); Belgium and Holland, 151 per cent. (from 2,331 to 5,858); and Great Britain, 107 per cent. (from 7,287 to 5,114). France and Italy are at the bottom of the list, the increase in the number of subscribers in the former country having been only 62 per cent. (from 4,437 to 7,175), and in the latter 52 per cent. (from 5,507 to 8,346). Great Britain still had the largest number of telephone users, 15,114; Austria the smallest, 3,032.

1887 IN AMERICA.

(FROM OUR AMERICAN CORRESPONDENT.)

While the advance made in electricity here during the year just closed has been eminently practical and commercial, there may still be chronicled progress in the various branches which involve theoretical application. Looking over the field we find first in the telegraph an addition to Edison's phonoplex of a year ago, by means of which he is enabled to convert a single line into a triplex, by means of two diaphragm receivers added to the regular Morse receiving apparatus. In his first apparatus but one diaphragm receiver was employed, which was made to operate by transmitting a momentary induction current over the wire, which snapped a telephone diaphragm, and which did not interfere with the Morse transmission. The additional diaphragm now employed is acted upon by a rapidly vibrating current, which is also read off in the usual way, the dots and dashes being recognised by the short and long buzzes.

This year also has seen the first line regularly equipped with the train telegraph apparatus, by which constant communication can be had between a moving train and the station. The system is employed on the Lehigh Valley Railroad, and it differs from that used by Phelps in 1885 in that static induction is employed instead of dynamic, the roof of the train being charged from the wire running alongside the track. I might also draw attention to the system devised by Absterdam, in which signals are re-transmitted automatically from the distant end of the line, so that all manual labour for the verification of messages is unnecessary.

In the field of telephony I would call attention to the "make and break" transmitter of Field. Heretofore, "make and break" transmitters have depended upon the action of the voice to perform the "make and break"; but in the Field and Eickemeyer transmitter the break is performed automatically, and, in fact, the transmitter is under constant vibration, the voice merely bridging parts of these "makes and breaks," affecting the current in the external circuit in correspondence with the vibration of the voice. Another telephone also brought out consists of a number of reeds placed in proximity to the magnet, the idea being that the articulations of the voice would be better recorded by employing receiving apparatus having a number of differently tuned vibratory receivers.

In the field of phonographs we find Edison at work on his old idea, but he has now come to the use of a cylinder of wax, upon which a graving tool cuts a line corresponding with the vibration of the voice. Bell and Painter have also worked on a similar line during the year. Berliner has brought out a phonograph, or "gramophone," in which he employs the old Leon Scott principle, by tracing a line on a flat disc covered with lampblack, and then employing this as a negative to produce a photo-engraving, which then serves as a guide or matrix to the stylus attached to the reproducing diaphragm. Of the electric speech recorders, we have that produced by Hunter, who acts upon carbon paper by means of a stylus attached to a diaphragm, compressing it in accordance with the vibrations of the voice, and then employs this carbon sheet for reproduction by including it in a circuit, which is varied by the vibrations in the resistance produced by the indentations first made.

In Irish's phonograph an incandescent stylus burns a line in a strip of paper, the depth of which corresponds to that of the articulations of the voice, and by then including this strip of paper in a circuit and feeding carbon to the strip, the resistance will be varied in correspondence with the depth of indentations of the strip.

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In electric lighting the various induction systems may be said to have almost monopolised attention in this country, though the continuous current has by no means been forgotten. The Westinghouse system has been further developed this year, and, in addition several new systems have been produced. Among these we note the ingenious application of Diehl, in which a continuous current is employed to send a pulsating one through two branch circuits, and thus by induction producing effects in the secondary circuits of incandescent lamps specially constructed for the purpose. After passing the two branches, the current becomes a continuous one, and may be employed for arc lighting and similar purposes. Pfankuche has also brought out an induction system in which he employs a continuous-current machine, the direction of the current being reversed.

During the year Elihu Thomson has brought out a very ingenious method of regulating three-wire systems by placing a motor dynamo in connection with the circuit, each commutator being connected to the other sides of the system. When the potentials of both sides are alike, the action of the two windings will neutralise each other; but, if one rises in excess of the potential of the other, that winding is converted into a motor which will drive the other winding as a dynamo, returning to the defective circuit the current which the other has in excess, and thus keeping the balance.

Eichemeyer has also brought out during the year an ironclad dynamo, in which the field coils are wound directly over the armature, the whole being enclosed in an iron envelope.

In the motor and electric railway branch America has seen wonderful developments this year. I need not enter into the number of new roads equipped or into the number of stationary motors that have been used during the year, as your columns have already chronicled those facts, but I may draw attention to a few novelties in this direction. Field has devised a system in which the tops of the conduits serve as rails, and within which is an insulated conductor. The conductor in one conduit is connected to the positive pole of the dynamo, the negative pole of which is connected to the ground; while in the other conduit the conductor is connected to the negative terminal of a dynamo situated at the other end of the line, with its positive terminal groundless. This keeps the resistance of the line constant, no matter where the car may be situated, and allows of working with two potentials, and in case of a breakdown of a machine at one end of the line, the other still keeps the road in operation. Irish has recently brought out a system in which the conductor is laid in a flexible conduit, the car passing over compressing the conduit, and making contact with the conductor within, but immediately releasing the contact when it has passed that point.

You have kept well up in the work that has been done in thermo-electricity during the year, and I only need mention by name, therefore, the Edison pyromagnetic motor, and the electric furnace generator of Berliner, and elsewhere I give the latest developments of Acheson. This brings me to the subject of batteries. There is very little to be reported in this, but I may foreshadow the early appearance of a form of cell which is claimed to remove all the difficulties which stand in the way of successful commercial lighting by primary batteries, so that not only in England but here is the question of lighting by primary batteries a live one.

ELECTROLYSIS OF IRON SALTS.

BY ALEXANDER WATT.

(*Concluded from page 187.*)

Persulphate of Iron and Sulphate of Potassa.—A weak solution of the persulphate was first obtained, to which was added a solution of sulphate of potash. With the current from four Daniell cells and large anode surface, a bright deposit of iron of a steel grey colour was obtained upon a brass plate soon after immersion. The deposition was rather slow at first, until the anode surface was increased, and there was a good deal of hydrogen given off. After the plate had been in the bath about half an hour, a good coating of iron was obtained on both sides of the plate, and small crystals of metallic iron were found attached to one corner of the plate, showing that the deposition had really proceeded with some rapidity during the time.

Persulphate of Iron and Sulphate of Ammonium.—It was next determined to ascertain if the addition of sulphate of ammonia to a solution of the persulphate of iron would favour the deposition of the metal. For this purpose a dilute solution of the persalt was taken, and to this was added a small quantity of sulphate of ammonia, which was dissolved, with stirring, in the liquid. On immersing a brass plate in this bath—the current from three Daniells being used—it at once become coated with a film of iron of a darkish colour, the upper portion of which was of a blue tint. The current being evidently too strong, a single cell was next tried, when a prompt deposit of iron of a dark grey was received upon a fresh plate. The solution was now diluted with water, and a new plate immersed, when the deposition took place more gradually, and indeed too slowly. Two more cells were now added, when the film upon a fresh plate was at first of a blue colour, but after a few moments it became tolerably white, and was perfectly reguline and adherent, the deposit having taken place on both sides of the plate, proving that the solution was a fairly good conductor. I may say that this result somewhat surprised me, for although I had succeeded in obtaining metallic deposits from iron persalts from various solutions, *as a matter of fact*, I never expected that a tolerably good depositing solution could be formed from such salts; but this, so far as I have gone with this latter experiment, really appears to be the case.

Persulphate of Iron and Sulphate of Soda.—A solution was formed by adding to a rather weak neutral solution of persulphate of iron, powdered sulphate of soda crystals, a little at a time, and stirring the liquid until this salt was dissolved. With the current from three Daniells, a deposit of iron at once commenced to form on the corners of a brass cathode, the film gradually increasing until the whole of the immersed surface—about two square inches—was covered. The deposit, which was of a blue-grey colour, was very streaky and irregular; to remedy this, if possible, the bath was further weakened by addition of water, which somewhat improved the character of the film; but this, however, still remained patchy or mottled. The bath was again diluted, at which point it was exceedingly weak, but still yielded a prompt coating of iron upon a clean brass plate. To obtain a uniform coating, and to improve the colour of the film if possible, the plate was now gently moved about in the bath—a large anode surface being exposed—when the metal deposited in a more uniform condition and of a good white colour. The results thus obtained further indicate the direction in which we must steer if we wish to obtain metallic deposits of iron from solutions of its persalts, with or without the admixture of other substances, namely, in the direction of the pump. Extreme dilution of the electrolyte appears to be an absolutely necessary condition. Although solutions of the persalts of iron have no practical significance so far as relates to the deposition of the metal upon other metallic surfaces for the purposes of art, I was desirous, in these latter experiments, to ascertain, *first*, if iron could be deposited at all from any or all of these solutions; and, *second*, under what conditions. In my first experiments with the persalts I was, in common with others, unsuccessful, and it was not until I had obtained an actual film of reguline metal from a pernitrate solution, that I became convinced of the possibility of reducing the metal from persalts provided the proper conditions could be arrived at. Those conditions I discovered after a very extensive and tedious course of experiments, and if I were to go over the same ground again I should exactly reverse the basis on which they were conducted; for, instead of commencing with a moderately-strong solution of any given persalt, and gradually reducing its strength, as occasion required, by additions of water, I should start with a measured quantity of water, and to this would add, by small quantities at a time, a concentrated solution of

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the salt under trial, these additions being made until a film of iron appeared upon a clean brass or copper cathode.

Perphosphate of Iron.—Hydrated peroxide of iron was digested in a boiling solution of phosphoric acid, and the solution afterwards filtered and diluted with water. With a current from three Daniells a blue film of iron was first obtained upon a brass plate, but after a few minutes' immersion the deposited metal acquired the characteristic colour of iron, though not so white as that obtained from a solution of the protosalt.

Lactate of Iron.—A solution of this salt was first prepared by digesting a quantity of fine iron wire in a strong solution of lactic acid for many hours, when a pale green solution resulted, which, after moderate dilution, was electrolysed with the current from three Daniells in series. There was a brisk liberation of hydrogen, and after a few minutes' immersion of a brass cathode a film of iron of a somewhat dark colour appeared upon its surface. No deposit could be obtained with a smaller number of cells than those mentioned. A solution of lactate of iron was also prepared by dissolving carbonate of iron in a strong and warm solution of lactic acid, and the liquid was used in its warm condition with the same number of cells, when a prompt film of iron was obtained upon a brass plate, but the colour, as before, was of a dark colour.

Perlactate of Iron.—A strong solution of lactic acid was first heated, and moist hydrated peroxide of iron then introduced in small quantities at a time, and the heat kept up until the acid was neutralised. The vessel was then set aside until cool, and the clear liquor, which was of a deep orange colour, was afterwards decanted for use. With the current from three Daniells in series, a dark coloured and somewhat iridescent film of iron slowly formed upon a brass cathode, and this was found to be firmly adherent. The solution was then gently heated, and tried with the same current, when the deposit was somewhat more prompt, and the colour of the film improved, especially when the plate was slowly moved about in the bath.

In pursuing the experiments described in this and the preceding papers, my aim was to obtain deposits of metallic iron, if possible, from even the most refractory iron salts, and in this, I am pleased to say, I generally succeeded, by making such modifications of current strength and density of the electrolytes operated upon, as from time to time occurred to me. In arriving at more or less satisfactory results with solutions that presented much difficulty, I frequently had to make a very considerable number of trials before I succeeded in finding out the conditions necessary to obtain the desired film of iron of a proper reguline character. When these conditions were approached, further investigation was often necessary to ascertain whether further modifications would give still better results; and it was not until such additional trials had been made that I felt satisfied with the final result of my labour. From a practical point of view, I am fully aware that many of the experiments I have recorded will have but little interest. To the student of electro-metallurgy, however, the behaviour of various solutions of metallic salts under electrolysis cannot fail to possess at least the interest which always attaches to fact. Indeed, when we consider the comparatively meagre information which has been furnished us by the various investigators of electro-chemical phenomena, concerning the electrolysis of metallic solutions other than those which have a more or less practical application in the arts, it would appear that further investigation should be made in this direction, and to this agreeable task I have for some time past—and purpose continuing to do so—devoted myself, believing that not only the student, but the practical electro-metallurgist, may derive some beneficial knowledge from the records of electrolytic experiments with a considerable number of metallic solutions.

If we consider the practical application of iron solutions in the electro-deposition of that metal upon other metallic surfaces, as in the so-called steel-facing of engraved copper plates, for example, I am disposed to give the preference to the following salts for making up iron baths, and if these are prepared with care, and from good materials, there should be no difficulty in obtaining good results from either of them. 1. The ammonio-sulphate of iron. 2. Sulphates of iron and magnesia. 3. Sulphate of iron and chloride of ammonium. 4. Sulphate of iron *per se*. To prevent the solutions from becoming oxidised many different substances have been added to iron baths, as glucose (grape sugar), glycerine, &c., but I am disposed to think, from experiments I made in this direction, that small doses of citric or tartaric acid will be found more effectual, while these vegetable acids have also a tendency to improve the brightness of the iron deposit. Again, in making up iron baths for the practical deposition of the metal, it is often recommended to employ an anode of large surface—that is, considerably larger than that of the article to be coated. I am disposed to suggest, however, that the strength of the solution and density of current should be so regulated that the metal will be deposited freely and uniformly with an anode surface about equal to or, at least, not greatly exceeding that of the cathode. My object in suggesting this is that I have found the metal to deposit well under such conditions from the solutions named, and such being the case, there can be no real advantage in greatly exceeding the limit of anode surface. A solution will, I believe, yield more uniform results and maintain its normal condition for a longer period if a uniform density of current be always maintained, and the liquid kept in such a condition that the iron will freely deposit when the electrodes are of about equal surface. To my mind it is generally a sign that the electrolyte is defective, or the current too weak, when a large anode surface is necessary to obtain a metallic deposit of good quality, and at a proper rate of speed to render the film adherent. In depositing iron from any of its neutral solutions great care should be taken, when lifting the article out of the bath to ascertain how the deposit is progressing, that the film be not exposed to the action of the air for any length of time, since the exposure of a few seconds only would be quite sufficient to form a film of oxide upon the surface, which would effectually prevent the subsequent layer of metal from adhering to the first. We all know, as I pointed out many years since, that metals do not adhere well to their kind when deposited by electrolysis; thus, gold does not firmly adhere to gold, silver to silver, and so on; but this is more remarkably the case in respect of nickel, which I believe cannot be made to adhere to the same metal by any electrolytic method whatever. I have been prompted to make the above observations in the hope that they may in some degree assist in guiding those whose inclination or duties may lead them to engage in the electro-deposition of iron upon other metals.

PORTABLE VOLTMETERS FOR MEASURING ALTERNATING POTENTIAL DIFFERENCES.*

BY W. E. AYRTON AND JOHN PERRY.

(*Continued from page 209.*)

The action of these instruments is quite easy to understand; but the mathematical calculation of the way in which the deflection of the pointer for a given potential difference is varied by varying the dimensions of the magnifying spring, the initial sag given to the wire, and the dimensions of the wire, is not quite so easy to work out. We have, however, succeeded in reducing the solution to a comparatively simple form, and the following comprises the consideration of—

A. The general formulæ and the law of graduation.
B. Waste of power in the voltmeter.
C. The range in volts of the voltmeter.
D. The greatest angular deflection of the pointer.
E. Uniformity of the scale divisions.
F. Correction for temperature.

A.—General Formulæ and Law of Graduation.

Let A O B (Fig. 10) be one of our fine wires or two opposite spokes of our bicycle-wheel form of voltmeter, the size of the hub being neglected. Let

$$AO = OB = \tfrac{1}{2} l, \quad OQ = y.$$

* Paper read before the Society of Telegraph-Engineers and Electricians on December 25, 1887.

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Let the diameter of the wire be d, and the specific resistance of its material be ρ when its temperature is θ degrees above the temperature of the surrounding metal case: then, if the case does not alter greatly in temperature,

$$\rho = \rho_0 (1 + k\,\theta). \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where k is the coefficient of increase of resistance per degree centigrade, and ρ_0 is the specific resistance of the material when θ is nought.

When $\theta = 0$,
let $l = l_0$,
and $y = y_0$;
then $l = l_0 (1 + a\,\theta)$,

where a is the coefficient of increase of length per degree centigrade.

$$y^2 + A\,Q^2 = \tfrac{1}{4}\,l^2,$$
$$y_0^2 + A\,Q^2 = \tfrac{1}{4}\,l_0^2;$$
$$\therefore\ y^2 - y_0^2 = \tfrac{1}{2}\,l_0^2\,a\,\theta, \text{ approximately} \quad . \quad . \quad (2)$$

since a is small.

In that very useful treatise of Dr. Everett's, "Units and Physical Constants," there are given the results of Mr. McFarlane's and of Professor Tait's experiments on the rate of loss of heat in air at ordinary pressure from copper for various differences of temperature between the copper and the surrounding space, but no indication is given as to the form of the radiating body, nor of its size, and hence people have used Mr. McFarlane's results as if they applied to bodies of any shape and size, and so have been led in some cases to erroneous conclusions. As a matter of fact, Mr. McFarlane's values for the rate of loss of heat by radiation and convection given in Dr. Everett's "Units and Physical Constants" *apply only to a copper ball of 2 centimetres radius*, since this, we find, was the cooling body employed by Mr. McFarlane in the experiments in question, as mentioned in Mr. McFarlane's paper communicated by Sir W. Thomson to the Royal Society in 1870.

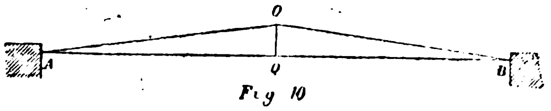

Fig 10

But in a very valuable book published two years previously to that—viz., in 1868—by Mr. Box, and called a "Practical Treatise on Heat," there is a table given on page 151 (which has been much used by engineers) showing the loss of heat from contact with air with horizontal cylinders and spheres. It was deduced, we rather think, from M. Peclet's experiments, and it shows clearly that the loss of heat per unit area increases as the diameter of the cylinder or sphere diminishes. Mr. Box used the Fahrenheit scale for temperature, a square foot as his unit of area, a pound for his unit of mass, and an hour for his unit of time; but, reducing his formulæ to the C.G.S. system, we find that the loss of heat (gramme, C. deg.) per second, per square centimetre of surface, per 1 deg. C. excess, is

$$0{\cdot}00005710 + \frac{0{\cdot}0001057}{a} \text{ for a long } \textit{horizontal} \text{ cylinder.}$$

$$\text{and } 0{\cdot}00004928 + \frac{0{\cdot}0003609}{a} \text{ for a sphere,}$$

a being in the former the radius of the cylinder in centimetres, and in the latter the radius of the sphere.

Applying Box's formula for a sphere to the case where a is 2 centimetres, the radius of Mr. McFarlane's ball, we obtain for the loss of heat (gramme, C.deg.) per second, per square centimetre of surface, per 1deg. C. excess, the number 0·0002297—a number which is between Mr. McFarlane's value for polished copper (0·000178) and for blackened copper (0·000252). There is, therefore, every reason for believing that Box's formula is at any rate approximately correct.

Let us take as a first approximation that the rate of loss of heat is directly proportional to the difference of temperature. This we know is not strictly true, and the error arising from the assumption will be furthered considered under section B—"Waste of Power in the Voltmeter." Then, if $\epsilon\,\theta$ be the heat-power *in watts* given out per square centimetre of surface of the wire when the excess of temperature is $\theta°$ C.,

$$\epsilon = \frac{0{\cdot}00005710 + \dfrac{0{\cdot}0001057}{a}}{0{\cdot}239}.$$

Now the resistance of the wires is $\dfrac{4\,l_0\,\rho}{\pi\,d^2}$; so that, if V volts be the potential difference at its terminals, $\dfrac{V^2\,\pi\,d^2}{4\,l_0\,\rho}$ watts are developed in the wire, and $l_0\,\pi\,d\,\epsilon\,\theta$ = heat-power emitted in watts; so that

$$l_0\,\pi\,d\,\epsilon\,\theta = \frac{V^2\,\pi\,d^2}{4\,l_0\,\rho} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

or

$$\theta = \frac{V^2\,d}{4\,l_0^2\,\epsilon\,\rho} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

If the thickness of the wire be very small, and if Box's formula continue to hold for very thin cylinders,

$$\epsilon = \frac{0{\cdot}0001057}{0{\cdot}239\,a}, \text{ approximately};$$

$$= \frac{0{\cdot}0008848}{d}, \quad \text{"}$$

hence

$$\theta = \frac{V^2\,d^2}{0{\cdot}003539\,l_0^2\,\rho} \quad \text{"}$$

so that to raise a fine wire of a given length, made of a given material, to a given temperature above that of the case of the instrument requires that the potential difference maintained at the ends of the wire shall be inversely proportional to the diameter of the wire, approximately.

If C be the current in amperes flowing through the wire,

$$C = \pi\,d^{\frac{3}{2}}\sqrt{\frac{\epsilon\,\theta}{4\,\rho}}.$$

Substituting the value just obtained for ϵ for very fine wires, we have

$$C = 0{\cdot}01487\,\pi\,d\sqrt{\frac{\theta}{\rho}}, \text{ approximately};$$

or the current required to maintain a fine wire of a given material at a definite excess of temperature is approximately directly proportional simply to the thickness of the wire.

This result was obtained experimentally by Professor Forbes in 1884,* but he appeared to regard it as a result that would not have been expected from experiments previously made on much thicker wires. Mr. Preece also published results,† in the same year, of experiments made on fine wires, and he also speaks of the results of experiments "contradicting" the law which he obtains theoretically. Whereas it appears to us that the current having to vary directly as the diameter, and not as the diameter raised to the power three halves, in order that *very fine* wires may be maintained at the same temperature, is in entire conformity with the true law of the loss of heat by radiation and convection, which was published certainly as early as twenty years ago by Mr. Box.

Equation (5) becomes

$$\theta = \frac{V^2\,d}{4\,l_0^2\,\epsilon\,\rho_0\,(1 + k\,\theta)},$$

or

$$\theta = \frac{V^2\,d}{4\,l_0^2\,\epsilon\,\rho_0\left(1 + k\,\dfrac{V^2\,d}{4\,l_0^2\,\epsilon\,\rho_0}\right)}, \text{ approximately} \quad . \quad (5)$$

One law of the magnifying spring is that

$$\phi = \frac{s}{r}\,(y - y_0) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where ϕ is the rotation of the pointer in radians, s is a number depending upon the material of which the spring is made, and has a value about 1 radian for phosphor bronze, and r is the radius of the spring.‡

* *Jour.* Soc. Tel.-Eng., Vol. XIII., 1884, page 243.

† *Proc.* Roy. Soc., No. 231, page 468.

‡ "A New Form of Spring for Electric and other Measuring Instruments," *Proc.* Roy. Soc., No. 230, 1884, page 306.

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Substituting for y from (6) in (2), we have, as

$$y = \frac{r\phi}{s} + y_0,$$

$$\frac{r^2}{s^2}\phi^2 + 2\frac{r}{s}\,y_0\,\phi = \tfrac{1}{2}\,l_0^2\,a\,\frac{V^2 d}{4\,l_0^2\,\epsilon\,\rho_0\left(1 + k\dfrac{V^2 d}{4\,l_0^2\,\epsilon\,\rho_0}\right)},$$

$$\text{or}\quad \phi^2 + 2\,\frac{s}{r}\,y_0\,\phi = \frac{s^2}{r^2}\,\frac{d\,a}{8\,\epsilon\,\rho_0}\,\frac{V^2}{1 + \dfrac{k\,d}{4\,l^2\,\epsilon\,\rho_0}V^2} \quad . \; . \; . \; . \; . \; . \quad (7)$$

or, if $A = \dfrac{s^2}{r^2}\,\dfrac{d\,a}{8\,\epsilon\,\rho_0}$, and $B = \dfrac{k\,d}{4\,l_0^2\,\epsilon\,\rho_0}$,

and if $\dfrac{s}{r}\,y_0$ be called ϕ_0, then

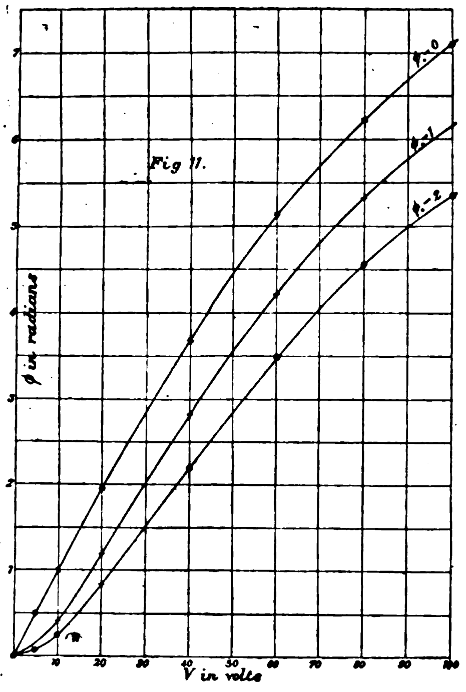
$$\phi^2 + 2\,\phi_0\,\phi = \frac{A\,V^2}{1 + B\,V^2} \quad . \; . \; . \; . \; . \; . \quad (8)$$

and hence

$$\phi = \phi_0\left\{-1 + \sqrt{1 + \frac{A}{\phi_0^2}\,\frac{V^2}{1 + B\,V^2}}\right\} \quad . \; . \; . \quad (9)$$

There are discrepancies in this result, due to—

1st. Our assuming (1). But it will be found that the error due to this assumption is not large for the usual temperatures of the instrument when platinum-silver wire is employed. See F—"Correction for Temperature."



2nd. Our assuming ϵ to be independent of θ. If ϵ is not constant, the law (9) alters in shape. As we never use (9) for the purpose of graduating, but merely to give us some approximate knowledge of a general law, this will not affect in any way the accuracy of the instrument.

3rd. We have not taken into account the fact that time is needed to attain the state of equilibrium indicated by (4), so that θ might be expected to rise higher on first starting the current than its true steady value; but we find experimentally that this time is quite inappreciable with a *very fine* wire placed *horizontally*.

4th. Our having neglected small changes in y due to the tensile strain in the wire. It can be proved that these are unimportant, except when y_0 is smaller than we are ever able to have it in our instruments.

5th. Our having dealt with certain small quantities as if they were indefinitely small.

B is found to be small in our instruments, and when y_0 is very small it is obvious that the deflection ϕ of the pointer is very nearly proportional to V, the potential difference. When y_0 is not small, the readings increase at first in proportion to the square of the volts, and then become more nearly proportional to the volts. In fact, the divisions for volts of the scale of the instrument get rapidly greater for small readings; then, as the readings become higher, the divisions become equal to one another; and, if the range is high enough, they become somewhat smaller again, due to the change of resistance with temperature making its effects felt.

For the sake of illustration we have drawn the three curves shown in Fig. 11, taking

$$A = \cdot 01$$

and $$B = \cdot 0001,$$

and the values 0, 1, and 2 for ϕ_0.

If such a spring is used that $\dfrac{s}{r} = 1$, then ϕ_0 is y_0.

(To be continued.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Dec.* 31*st*, 1887.

Not long since a meeting of telephone experts connected with the American Bell Telephone Company, and its sub-organisations, met in this city to discuss in a private, informal way, the best types to be adopted in telephone cables. Owing to the fact that during the discussion various new ideas, more or less patentable, were brought to notice, it has been decided not to publish the report, which has therefore been printed for private circulation only. The practical result of the conference was so good, that another of a similar nature has just been held, with the object of discussing the most desirable forms and arrangement of exchange apparatus. This subject has been given peculiar prominence to by the many difficulties encountered in equipping the big new switch-board for the Metropolitan Company in this city, to be placed at the top of its handsome new building in Cortlandt-street. Some idea may be formed of this board when I mention that it is divided into 44 sections, and will have a capacity up to 10,000 wires, although at present the working equipment will be limited to 6,000. This board will have a length of about 300ft., and will be arranged in the shape of a square U. In order to make the connections, considerably over one million soldered joints are necessary in the board, and over 3,000 miles of wire and cable are being used. At one time more than 100 men were at work on the board for two months steadily, and the regular work has gone on for several months without intermission. The board was already nearly ready for work when the wholesale undergrounding of the telephone wires throughout the city led the company to make all the circuits metallic. This involved many changes and much new work, and a total expense to date of over £60,000. As may be imagined the construction of this board brought to light many new problems, and its progress to completion has been anxiously watched by large exchanges all through the country. It is at this juncture, therefore, that the second conference mentioned above has been fittingly held. It was attended by such well-known experts as T. D. Lockwood, E. J. Hall, jun., W. Wiley Smith, J. A. Seely, B. E. Sunny, E. M. Barton, C. C. Scribner, H. Metzger, and others, and its deliberations are understood to have been productive of much good in the way of suggestions and eliciting the experience of many years of work in this special work. One result arrived at, it is said, is the decision that, in spite of the many obvious objections, it is desirable in large cities to combine all the wires and connections as much as possible under one roof up to the number of at least 5,000 subscribers. Beyond that point, the conclusion seems to be it is better for the present to relieve the central office by a system of minor exchanges. The proceedings of this conference will, as in the other case, be printed for private circulation.

I believe note was made recently in this letter of the work proposed by the Lighthouse Board in connection with lighting buoys by electricity. The first experimental work of the kind

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is at once to be carried out in New York Harbour with Edison 50 candle-power lamps, and Bishop gutta percha cable. The Board proposes to ascertain whether in the first place it is practicable to light the buoys at all in this way, in spite of storms, ice, &c., and whether it is possible to use the earth as a return. The Board also promises itself to make some inquiries into the conducting capacity of cables for this and similar work. It is evident that here, as in the case of the experiments in England in regard to communicating with lightships, some very interesting and important work has been undertaken, and the results will be eagerly awaited.

Indications are not wanting that considerable strides will be made during the coming year in the department of thermo-electricity. A recent development in this line is that of Mr. E. G. Acheson, of Pittsburgh, who, in order to increase and maintain differences of temperature between the two elements so as to secure a corresponding difference of potential, separates the elements by a moving conducting fluid, and applies heat directly to one of them so that the temperature of the other element can never rise above the boiling point of the separating fluid. Thus, while the element to which the heat is directly applied may be raised to a high temperature, the other element will remain comparatively cool, and thus a current of fair electromotive force will be obtained in the external circuit. Another point is that owing to the movement of the fluid the accumulation of gases on the surface of the solids is prevented, and thus a diminution of the current from this gas does not take place. In another form of this apparatus Mr. Acheson used a heated gas instead of the liquid as a conducting medium. In thermopiles as usually constructed two dissimilar metals are used, but in this apparatus only one kind of metal is employed. It may strike the reader as rather singular that in one form of this apparatus water or some such liquid should be used as a conducting medium, and that in the other a gas should be resorted to, but it will be remembered that gases when heated become far more conductive electrically. Very few details are yet given or obtainable as to the work of this apparatus in its most recent forms, but it would seem, if put in practicable shape, to provide means for the extensive utilisation of waste heat, in the form of current that could be stored.

There does not appear to be much that is new to record in the line of secondary batteries, except that considerable use is now being made of them in work where a year ago their employment was regarded as inadvisable, and even out of the question. There is no doubt that during 1888 plans now being projected will be carried out for the use of secondary battery plants on a large scale to be used either independently or in conjunction with central lighting stations now in operation. No small amount of work is also in hand in connection with street railway work, and the number of storage cars running on the streets will soon be very largely increased. Some little interest, by the way, is taken in the animated controversy which has sprung up between the Julien Company and the Electric Car Company, of America, operating the Reckenzaun system, as to whose car can make the best record. The Reckenzaun car on the trial tracks at the works at Philadelphia has made a record of over 63 miles with one charging of its batteries. The Julien car running on the Fourth Avenue line in this city, and traversing up town some of the roughest street car tracts in Christendom, has a record of over 40 miles to its credit, and is, I may add, now in daily service on the road, doing, it would appear, very good work. Each company is very well pleased with the results obtained, and with the better records that can be made without much effort; and it is whispered that each is willing to back its own car, so that it would not be surprising if some sort of challenge comes out of the dispute. Possibly, as in the case of the projected race across the English Channel by storage boats, the race will not take place; but this controversy will at least serve the purpose of calling attention to the marked improvements and advances that are being made in electrical street railway work.

While speaking of secondary batteries I may mention that Mr. A. V. Meserole, of this city, who has done quite recently some experimenting, reports that a good battery can be made, with carbon as an active absorbent, by the use of such carbonised vegetable substances as bamboo or boxwood, pulverised, and mixed in varying proportions with graphite, and then pressed into porous pots or bags. The material is worked into a paste with acidulated water, and then compressed into the porous envelope with a number of conducting plates or rods composed of an alloy of lead and antimony amalgamated. The usual grid may also be filled in with this plastic material, and then wound around with asbestos tape or cloth to prevent its erosion. The capacity of the element may be increased by the addition of oxide of lead to the mass forming one electrode, and the same may be said of the addition of oxides of various other electro-negative and electro-positive metals to the respective secondary poles, though this method brings back, of course, the objectionable features which the use of carbon is intended to avoid. Such a grid as he proposes, says Mr. Meserole, would have a constant conductivity, and would be practically indestructible with the use of any sort of electrolyte.

Reports come from Richmond that the Sprague electric road there is beginning to assume good shape, and that before long it will be in excellent running order. This road is a difficult one to operate by any system, and is also extensive, no fewer than forty electric cars being required in all. The Sprague Company is now busily engaged getting ready the equipment and forwarding it.

Over in Brooklyn the Van Depoele Company have just put a nice road in operation running from the outskirts to the suburban town of Jamaica, a distance of six miles. This road has practically no grades, and very few curves of small radius. It also has the advantage of running along what is still, to all intents and purposes, a private toll road, where civic authorities, with their prejudices, absurdities, and hungriness after backsheesh, cannot easily intrude. Another advantage is to be found in the fact that the road runs through a region which is being rapidly filled up by the overflow of the population from the "city of churches;" but perhaps the greatest advantage of all is to be found in the fact that it skirts about half a dozen cemeteries, and is bound to do an enormous business on Sundays, as well as every holiday of the year. At the stables of the company on the road, shoulder to shoulder with some of the new electric cars, are to be seen some of the oldest street cars used in this country, and the contrast speaks volumes. The Van Depoele people have also excellent reports from their road at St. Catharine's, Ontario, operated by water power from the Welland Canal. This road is about six miles long, and the secretary of it reports that the system, besides giving great satisfaction to the public and his company, is effecting an economy of about $18 a-day, as compared with the previous animal service. From Mansfield, Ohio, comes encouraging news of the operation of the Daft system there on a road about 4½ miles long, with five cars in use. Altogether prospects of the electric railway are very bright.

The efforts of some of our largest cities to put into the hands of the authorities the supply of electric light continue unabated, and are perhaps being made with more energy than ever. In Philadelphia, where it might have been supposed the results with the City Gas Trust would have been a sufficient lesson and warning, it seems to be the resolve of a large section of the community and of some members of the City Council to throw the electric lighting companies out of business. At the last meeting of the Common Council there it was proposed to cut out the appropriation of some £30,000 for public electric lighting, and notice was given to bring in an ordinance, providing the city should build its own plant, estimated to cost about £80,000, to supply 1,500 arc lights. Of course, such a proposition was warmly combated; but at the meeting for the award of the contracts a few days after the same spirit of opposition made itself manifest, and delay was secured in awarding the contracts. The new bids from the old companies cover about the same territory as before, but offer a reduction of about 4½ cents per

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light per night, making a total reduction for the year of about £1,700. The companies interested, which form what is known as the Electric Trust, being all practically under one management, consider that they have offered fair and reasonable rates; but the opposition is still after their scalps, and it is probable that, even if the contracts are awarded, more will be heard about this matter.

CORRESPONDENCE.

THE SWAN FIRE-DAMP INDICATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the description of the Swan fire-damp indicator of the 23rd December, 1887, there is no mention of a screen of gauze to enclose the platinum spiral.

The action of the apparatus in question is based upon the combination of hydrogen and oxygen gases, which is promoted by heated platinum, and is the principle of an apparatus which I designed for the same purpose some years ago.

During my experiments with this apparatus I found that the platinum, after having been frequently heated by the gas, acquired the property of causing the combustion of the gases when not being heated by the battery current, and of itself becoming incandescent and exploding the mixture when gas was present in explosive proportion, and further of not indicating anything in pure coal gas.

It appears to me, therefore, that some considerable care must be exercised in waving about such an apparatus in an explosive atmosphere, in the manner described for charging Mr. Swan's indicator.

A less dangerous expedient would be to take a sample of the air to be tested in an india rubber syringe and perform the operation cautiously on the ground.

It is mentioned that a red hot wire produces these effects; but it is not necessary that the wire be red hot. A warmth just perceptible to the finger was all that was necessary in my fire-damp indicator, and the platinum became more sensitive with use, two good Daniell cells being all that was required to operate the apparatus.

That some misconception exists as to the temperature required for this kind of combustion is evident from a description of my apparatus which appeared in *Engineering* at that time, and in which the writer, who had never seen it in operation, described it as impracticable on account of the difficulty of maintaining the current necessary to heat the platinum. The current required had actually been furnished by a very small battery for some months continuously by day and night.

There are other conditions under which coal gas will ignite without the wire being heated; for instance, if a proper mixture of gas and air, slightly warm, be directed from a jet against a roughened edge of platinum foil, it will ignite, and if the mixture be a little warmer still, it will act in the same way upon the edge of a similar piece of iron.—Yours, &c.,

17, Cornhill, E.C., 11th January, 1888. F. HIGGINS.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

MR. EDWARD GRAVES' PRESIDENTIAL ADDRESS.

The first meeting of this Society for the present year was held at the Institution of Civil Engineers yesterday (Thursday) evening, January 12th, when the new president, Mr. E. Graves, Engineer-in-Chief of the Post Office Telegraphs, delivered the following address:—

According to the poetic mythology of ancient Greece, Minerva, fully grown and armed, sprang from the brain of Jove; Wisdom was perfect at its birth; neither study, observation, nor experience were necessary to bring it to maturity.

But the wisdom of the early civilisations dealt only with the external aspect of the material things. The hidden secrets of Nature were undisturbed. The philosophers of those days forebore to look below the surface, nor did they call into activity forces dormant until the moment that the researches of the investigator should stir them into life.

When that period arrived it was manifested by progress in a very different manner from the sudden growth symbolised by the myth of Minerva. First, the observance of strange phenomena, and of the fact that their reproduction, under similar or differing conditions, as the case might be, was possible. Next, the discovery of distinct purposes that could be effected, by the utilisation of the same force that had given rise to the phenomenon originally observed. Then, the knowledge of the means by which this force could be produced, to whatever extent it might be required or be capable of, and that when produced it could be controlled; and lastly, the combination, into a definite scheme, of the results of all these researches and discoveries, so that the principles regulating the new science might be formulated, and its leading laws made known—thus creating a basis upon which could be ultimately moulded a more or less valuable addition to the resources of the human race.

The various stages through which the growth of any original science must necessarily pass can be stated in a brief paragraph, but to realise them centuries are often required.

Electricity and magnetism (which may be regarded for our present purpose as varying expressions of the one original power) furnish a clear illustration of this fact. Even now our knowledge, both of the agent itself and of the possible uses to which it may be applied, is very incomplete; but being what it is we can clearly trace its evolution.

Neglecting the earlier observers, who merely noted the existence of startling facts which they neither endeavoused to reason upon nor explain, we may fairly say that from Gilbert, of Colchester, to Faraday, three complete centuries were occupied in nearly continuous investigation of the laws that govern the action of the mysterious agency, and of the methods by which its powers could be controlled and employed. A long list of names of distinguished men in all civilised countries shows that many minds co-operated in the inquiry, and aided to piece together, observation by observation and discovery by discovery, that mighty outcome of scientific origin which, in many respects, has revolutionised the material world, and will still further—how much further one dares not say—influence its destiny.

Faraday and Joule may be regarded as the last workers and discoverers—of English birth, at least—in the field we are considering, who trod its path with absolute devotion to pure science alone. They and their predecessors noted facts and deduced principles; they stored up a mass of observations for the guidance of their successors, but they did not seek to apply them so as to turn the knowledge that had been gained to commercial account.

A different state of things now exists. Long prior to Faraday's decease other earnest students of electric science saw that in realising the triumphs that it might attain, benefit might be secured to their race and to themselves alike. The hour had come when the labourer could reap the reward of his efforts, and profit by the devotion of his life to the study of Nature's laws. Since then, every distinguished electrician has applied the science he loves to some practical purpose. When success has been secured in one department it serves only as a spur to further exertions, seeing that success means reward, and thus the recurring stimulus produces greater and greater efforts, and wider and more far-reaching results.

The object of the compiler of this address has been, however imperfectly, to trace the nature of the benefits already conferred upon the world by the use of electricity in some of its varied expressions, and to gauge the extent of the employment it has given by means of its operations, to at least the inhabitants of our own country.

It is almost impossible to express the variety of ways in which the action of electricity is utilised. Their name is legion, and they are ever multiplying. Communication between distant places was the first widely extended purpose to which it was practically put. Originally its operations were confined to points separated by land only. Then intervening rivers, channels, seas, and oceans were successfully crossed, until now nearly the whole earth is bound together by submerged chains—a kindly bondage that is another name for union. One ocean only—the Pacific—remains uncrossed, and the barren distinction will hardly be much longer preserved. One country of importance only—the Empire of China—has hitherto been reluctant to encourage the lightning messenger, but that reluctance appears to be on the verge of disappearing.

Another most prominent utilisation of electricity is for the purpose of illumination. First practically discovered by Humphrey Davy, its powers in this direction were successively made practical by Wylde and De Meritens, Pacinotti and Gramme, and by many eminent scientists of later date. Electric lighting has passed very many stages. Differing from telegraphy, it needed a longer period of trial and experiment after its commercial application began; and it is, of course, exposed to the competition of other illuminants ever seeking, by new methods, to lessen its superiority. Economy of production is, perhaps, the great necessity for its complete development. As the light of brilliance, health, and beauty, its claims are universally acknowledged; but the commercial problem can hardly be said to be yet completely solved, although the steps taken in that direction give promise of a satisfactory solution being not far off; the problem of distribution is becoming understood.

Telephony—in other words, telegraphing by means of the sonorous vibrations of the human voice, and not by means of signals controlled by the human hand—came into the field comparatively recently, but has met with wide acceptance, and has had a vigorous growth. It has been welcomed in all countries as a boon to humanity. The delicacy of the instruments by which it is worked is, perhaps, the source of greatest difficulty that its further development has to overcome; their sensitiveness

is alike manifested to intended and unwished-for influences. Since their inception we have had means of observation far more delicate than any previously in general use, but we have also discovered that the influence of "induction" is apparent to a much greater degree than was before deemed probable as an interference with the practical working of electric communications for commercial purposes.

In electro-metallurgy, electro-plating, electro-typing, and the like uses, electricity operates in many different directions. In some branches it is employed as a new and better way of producing the same results that were previously produced by inferior means; in some the results attained are novel, as well as the methods employed.

The substitution of electricity for steam, water, or gas, as a source of power, capable of driving mechanical engines, either stationary, locomotive, or marine, and the transmission of similar power to a distance from its source of origin, although successfully carried out in many important instances, may be considered as yet rather in the earlier stages of experiment and growth than of those of completion. There is a wide field yet to be explored in this direction.

For medical purposes electricity is also extensively employed; but I confess that I am unable to separate the wheat from the tares—the really curative agent from the imposture—and therefore can only say that it is evident that much may be done in this direction; much is already done, but the extent of the area it will finally occupy cannot yet be perceived. When the real nature of the power employed is understood, then we can better appreciate the nature of its influence upon the ailments to which the human frame is subject.

As a warning against fires that may threaten our houses, an agent employed to summon helpers to our relief, the electric current renders great service, that will, it is to be hoped, be availed of more extensively in the future than it is at present.

Electricity is also utilised to an increasing extent as a safeguard to the lives of the toilers in our coal mines charged with explosive gases. As yet it is somewhat in an uncertain stage in this respect—its use is proved, the desirability of its employment recognised, and efficient instruments for the purpose devised, but practice is yet needed to remove the difficulties in the way of its general adoption, to overcome the inertia that blocks its path.

Like the steam hammer that can strike with the weight of many tons, or crack a nutshell with a gentle tap, electricity can unite sundered continents or serve as a household convenience. For ringing the bells of our houses it has practically superseded the apparatus of pulleys, cranks, and movable wires; it can be operated over distances to which they were inapplicable. For submarine mining, blasting rocks, firing discharges that cause mountains to crumble, and for the purposes of warfare, the heat-conveying powers of electricity are extensively employed.

The last of the uses of electricity that I will particularise was one of the earliest to be availed of—a species of telegraphing with a special object, guiding trains on their way, and guarding against the risk of collisions by night and by day. When steam had won its greatest victories, it was necessary that some swifter and more subtle power should be at hand to control and regulate its action. Such power was found in the use of electricity, by means of which signals are given that track and guide the moving train throughout its journey. The line of railway is divided into successive sections, into each of which a train is forbidden to enter until the electric indicator gives permission, such permission being withheld until it is announced, by similar means, that any preceding train has passed from the further end of the section, upon which its successor is allowed to enter.

I have so far specified a few of the leading purposes for which electricity is employed, but to enumerate them all is practically impossible; the sphere of its influence is widening every day, and no one can attempt to say when its ultimate limits will be reached.

Only on Saturday last I saw an announcement in an evening journal to the effect that it had been discovered that the passage of a powerful stream of electricity through sewage water effected the division of the solid from the liquid constituents of the latter. No practical description of the *modus operandi* was given; but the bare announcement, whatever the results, shows a new direction in which some minds, at least, hope that profitable employment for the electric agent may be found.

It is clear, however, that in the great majority of its applications electricity is used as an agent—a tool, so to speak—for producing effects hitherto obtained less perfectly and less extensively by other means. For illumination, the supply of power for plating and many other purposes to the production of which electricity is applied, means existed in one form or other before the use or value of the latter was known. The improvement, however, effected by its use in some processes has been so great that it amounts almost to a discovery, and in almost all there is still great scope for increased progress.

One of these processes may be mentioned in the case of the electric light as applied to the illumination of ships—notably passenger steamers—at sea. The contrast between the comparatively dim oil lamps and the bright glow of the incandescent lights is so great as to make the latter really a new thing. Gas cannot, for self-evident reasons, be commercially applied to our floating palaces. Electricity has therein found a field in which it has no competitor.

Telegraphy and telephony, however, have introduced a really new thing into the world. True, the word "telegraph" was applied to an instrument—the semaphore—which preceded that which we mean when we use the same expression; but its operations were so limited—darkness or fog suspending them entirely—that no real comparison between the apparatus of Wheatstone and Morse and their so-called mechanical predecessor can be instituted. A few lines of gaunt-looking frameworks, on which hung pendant legs and arms of wood, or closing and opening shutters worked by levers, stood at considerable distances from each other. The signals expressed by the persons controlling the first machine in any such line were noted by an observer stationed at the next machine, through a powerful telescope; from the second they were repeated to the third; and so, when the light and weather permitted, they reached the final point communicated with, sometimes with very considerable rapidity. Nearly all such lines—and they were not many in England—were entirely for the Government service, chiefly that of the Admiralty. The only long private line of communication of the kind of which I am aware was that belonging to the Mersey Docks and Harbour Board—from Birkenhead to Holyhead—used for signalling the arrival or departure of vessels. Imperfect as such means of communication—often interrupted—were, when their operations *did* succeed they were enough to show how great the advantage would be to the world in general if they could be permanently depended upon. Hence arose the efforts of Ronalds, Sœmmering, and others; but the time was not fully ripe. The discoveries of Galvani, Volta, and Œrsted, however, combined with the result of preceding experience, led to the construction of the telegraphs of Gauss, Weber, Schilling, and Steinheil; and, finally, the endeavours of Cooke and Wheatstone in England, and Morse in the United States, resulted in the production and general use of a reliable means of long-distance telegraphy, which has since been improved upon in many ways, but which, in its essentials, remains the same.

Now let us see what is the outcome of all this thought, inventive genius, and intellectual energy. What has the thing they produced done for us?

Let us compare, say 1837—when Cooke and Wheatstone first demonstrated the practicability of their system—with the facts of 1887.

In 1837, whenever a member of any family, however highly placed, left the shores of his native country, he was lost to his friends—he disappeared, as it were, from their lives. He might be heard of at more or less frequent intervals by correspondence passing through a slow post, but in no emergency, however great, could he be communicated with in time to admit of his taking prompt action; separation was realised and its real meaning felt. For instance, in 1834—and the conditions were little changed in 1837—when the first Melbourne Administration was dismissed by King William IV., a special messenger, despatched from Brighton on the morning of November 15 to Sir Robert Peel, then at Rome, could only carry to him the offer of the Premiership in ten days' time; making all possible speed he only arrived on November 25.

At the present day let a man travel throughout the world, he holds in his hands, as it were, the strings communicating with his own home. Twenty-four hours, in practice, is an extreme period to elapse between the despatch of an urgent summons, or the communication of an important piece of intelligence, and its acknowledgment by the recipient, even at the ends of the earth. Last month Lord Hawke died at the St. Pancras Hotel. His son and successor was cricketing in Victoria, Australia, but in a few hours he received the sad intelligence, and will be home long before he could have known of the necessity for his return in the former state of things. Take the converse of this case. A criminal fleeing from justice wishes, of course, to cut off all traces of his connection with the place whence he flies. Fifty years ago he could do so easily; a few hours' law at the start would enable him to elude pursuit effectively. He could escape by sea and know that he could not be followed for a certain number of days, and that on his pursuers arriving at the foreign shore they would find him gone—vanished into the far-spreading regions of the West or South—where no clue could be found. Now let a man succeed in catching the fastest steamer that skims the ocean, and let him do so unobserved by his trackers here, he arrives at New York, Cape Town, Sydney, Melbourne, or Suez, only to find the police awaiting him, and ready to return him, by the quickest available means, to answer for his misdeeds.

In some quarters there is a tendency to question whether our modern improvements have really tended to increase the happiness of the world; whether there was not more real comfort when the pace was not so fast. A recent novelist has entitled one of his last productions—the period of which is laid in the last century—"The World Went Very Well Then," implying, of course, that the present day is, at any rate, very little better; this is not the general feeling. There may be a germ of philosophic truth in it, but mankind does not, as a rule, govern itself by philosophic ideas. It may have been possible for a merchant of 50 years ago, who knew nothing of the changes of markets or of the political occurrences that had happened which might govern them, or affect speculative risks, save on the arrival of weekly, fortnightly, or monthly mails, to be content that he was spared the worry of concerning himself every day with such matters; but now the telegraph brings him daily or hourly news. On all these points he has, at least, the advantage that no catastrophe can mature during his period of ignorance, and burst on him like a thunderstorm when the periodical notification arrives. Counting-house speaks to counting-house, not face to face, but in effect almost as if it were so. Orders have been despatched by post to be executed in London, and the goods sent to Calcutta; a turn of the market at the latter place shows that the execution of the orders will be a misfortune; the telegraph is employed and they are countermanded, no mischief being done. Shares that are held in various parts of the globe are suddenly greatly appreciated or depreciated at one of the great commercial centres: the facts are at once transmitted by wire to the others, and all markets are, at nearly the same time, placed on the same footing. The possibility of dealing rapidly in one centre, and of perhaps reversing the operation in another, is rendered, under ordinary conditions, impossible; no such *coup* as that by which Nathan Rothschild gained £2,000,000 by his energetic exertions to secure early intelligence of the result of Waterloo is now possible. To a large extent individual chances are equalised, at any rate so far as they depend upon the securing of rapid knowledge of occurring events. It is argued that this is an evil to the smaller firms, that houses with a large command of means can bear the cost of communicating freely by wire, and thus the possession of capital

tells more heavily than before in the race of competition against the lesser houses. There is some truth in the contention, but it is but one illustration of the general tendency of modern trade, which more and more shows that success in all the wider fields of commercial life is mainly secured by the operation of gigantic concerns working with vast resources, whether wielded by a single person or by an association. Individuals suffer in this struggle of competition, but the world at large profits by the increased magnitude of the aggregate business done ; and the facility of rapid communication is not the least potent factor in bringing about the results we are witnessing.

In political matters the lightning messenger is not less powerful for good. Formerly, intelligence of some disturbance or menacing event was received at headquarters on a certain day, and nothing could be heard in reply, nor any direction given, until many successive events had transpired, and perhaps irremediable mischief had been done. In its early days, also, to put the telegraph in motion was of but doubtful advantage ; the despatches were too brief, the orders were too curt—they were often misunderstood—rarely was their motive explained. In later times it has been found possible, on sufficient occasion, to exchange by telegraph despatches as full and clear as could be transmitted by letter, and thus no ground is left for the growth of misunderstandings that might produce international evil. Formerly irritated feelings grew up, and those whose duty and desire it was to soothe them were too late before they could apply any effective check to the popular passion that was urging either side into courses that could only culminate in war. The excitement that convulsed this country when Commodore Wilkes forcibly took the Confederate envoys from the mail steamer "Trent," and very nearly brought two kindred nations into a miserable conflict—there being then no cable connecting England with the United States—and the speedy collapse of the fierce fever that overspread France this year, when the frontier squabbles with Germany culminated in the forcible arrest of Schnaebele, followed later by the unfortunate shooting of French sportsmen by Germans, are instances of the advantage of the telegraph being in existence. The statesmen on either side were enabled to promptly calm the feelings that threatened much at first, but speedily collapsed when the trifling character of the unlucky accidents was understood. Perhaps the ease with which directions can be transmitted from the centre of Government to colonial governors or military commanders should be admitted to have some drawbacks attaching to it. Of course the full circumstances of any special situation can only be known to those absolutely on the spot, and it is an evil when the transmission of too detailed instructions to them destroys the sense of individual responsibility in the officers commanding abroad. The telegraph makes much possible for the Minister at home, but in some things discretion is best shown by abstinence from its too extensive use. Again, to take another form of superfluous energy as an example, it was, to say the least, unfortunate that, when the British and French armies were engaged in a life-and-death struggle with the Russian foe in an inclement winter in the Crimea, Lord Panmure, the then Minister for War, found the single wire laid between Varna and Sebastopol convenient for desiring the English Commander-in-Chief to "take care of Dowb"—his relative, Major Dowbiggin.

News, in its widest sense, is a very different thing now than it was formerly. A newspaper of the earlier portion of this century contained intelligence from all quarters, no doubt, but it was not contemporary intelligence, nor at all regular in its appearance. From the nearer capitals of Europe it might perhaps be two or three days old only, but in the same journals that printed this news appeared articles from the more distant parts of the globe dated two, three, or even five months before. For instance in 1837, in *The Times* of July 20th, there appeared news from Valencia, Spain, of Carlist operations on July 15th ; the semaphore having been utilised for its transmission across France, but its news being broken off because darkness had come on. On July 26 news was published from Rome dated July 16th. On the 28th of that month the dates from Hamburg were July 23rd ; but in the same issue Constantinople intelligence of July 7th was printed. From Quebec, news to the 3rd July did not appear until 3rd August ; and from New York, May 4th is the latest date mentioned on May 29th. From Tasmania, news to January 27th was not made known until May 30th. From the Cape of Good Hope, intelligence to March 25th was not published until May 30th ; and on the same day Calcutta advices to January 27th appeared. Sydney letters of December 31st, 1836, were made public on June 8th, 1837 ; and, in the same paper, Batavia reports of December 28th preceding appeared. Buenos Ayres news of March 19th saw the light on June 13th.

In an earlier issue of that journal, under date of December 10th, 1834, appears a paragraph calling attention to an instance of unexampled rapidity of communication between Liverpool and New York, letters having crossed the Atlantic three times within 65 days. The vessels conveying them made unusually quick passages, and each departure took place within a few hours of each arrival, the correspondents taking advantage of them to despatch their communications without loss of time.

Since that period an entire change has appeared on the face of journalistic matters. If a cricket match takes place at Sydney, New South Wales, on December 10, the full score appears in *The Times* on the morning of December 12, the intervening day being Sunday, but 10 hours being represented by the difference of time between the longitudes of Sydney and London. On December 23 a resolution of the New Zealand House of Representatives, on the subject of Colonial Defences, dated December 22, appeared in the first edition of the same journal. And on December 31 a message appeared in the second edition of the *Globe*, printed at 12:30 p.m., dated the same day, giving the substance of Mr. Chamberlain's speech at a banquet at Toronto the previous night. If despatched at 6 a.m., the difference of time alone would make it five hours later before it could reach London.

Not only events of mighty import to the interests of nations, but records of comparatively trifling matters—the appearance of a popular actor, the result of a boat race, and the like—are flashed across the world, and published here as they would be had they transpired in some city of our own island. The world has indeed become very small, if its dimensions are to be measured by the rapidity of knowledge in one part of the facts that occur in another.

Again, as regards our own country alone, a most remarkable change has occurred in the character of the press. Fifty years ago the most important speeches might be delivered a few hundred miles from London, and they appeared in the shape of a meagre, condensed summary the second or third day after delivery. They were no longer new when they could appear at all, and hence it was not worth while publishing them at length when they did appear ; perhaps, however, this imperfect publication had the compensating advantage of lessening their frequency, so far as readers were concerned. Now, if Mr. Gladstone speaks in Midlothian, Lord Hartington at Dublin, or Lord Salisbury at Liverpool—although it may be close on midnight before their oratorical efforts are completed, yet next morning the broad sheets of our daily press will give us, verbatim, all that their audiences have listened to ; and, in fact, the readers of London papers often know much earlier than the residents of a village ten miles from the place where the discourses were delivered what were the very expressions of the distinguished speakers.

It is not, at the present day, conditions of time or distance that limit the fulness with which an oration appears, the morning after delivery, in the newspapers, but only the amount of popular interest which the conductors of each particular journal believe will be taken by its readers in the speaker's words. Audiences are no longer confined to those who can be present in the largest halls ; on the wings of the telegraph, and by the agency of the newspapers, the speaker addresses the whole world, or at least such portions of it as care to know his opinions on the subject of which he speaks.

(To be continued.)

THE POSITION AND PROSPECTS OF ELECTRIC LIGHTING IN THE METROPOLIS.

On Tuesday evening Mr. W. Lant Carpenter, B.A., B.Sc., Manager of the School of Electrical Engineering in Hanover-square, read a paper at the monthly meeting of the Middlesex Natural History and Science Society, at the Society's rooms, 11, Chandos-street, Cavendish-square, W., "On the Position and Prospects of Electric Lighting in the Metropolis." There was a crowded attendance, and the room was lighted by the Union Electrical Power and Light Company. The Earl of Crawford had been expected to take the chair, but was prevented from doing so by a political engagement at Wigan. Letters and telegrams were read from other gentlemen, regretting their inability to be present.

Mr. Arthur Coates took the chair, and the lecture was amply illustrated by experiments and lantern illustrations. The chairman having briefly introduced the lecturer, Mr. Carpenter began by a brief comparison of the means of producing, storing, distributing, and consuming gas and electricity for lighting purposes. In reference to the use of primary batteries being limited by cost, he spoke specially of the Upward batteries, and sketched the development of the dynamo from Faraday's discovery, the main point in connection therewith being the following figures :—

Comparison of a 1,200 Light Dynamo 1882 and 1887.

	1882.	1887.
Weight	44,820lb.	11,760lb.
Bulk	320 cub. ft.	180 cub. ft
Absorbed H.P.	154 H.P.	112 H.P.
Commercial efficiency	67 per cent.	93 per cent.
Price per 100 watts output	£29	£6
Price per lamp	£2	7s.

In nothing, he said, was the progress in five years so remarkable, and one could not reasonably expect much greater commercial efficiency. Pointing out the difference between direct and alternating current machines, the lecturer said the principal examples of alternating currents were at the Grosvenor Gallery and Paddington Station, and the disadvantage of that was that they could not use secondary batteries, without which he did not consider that any installation of electric light was complete. He briefly traced the history of storage batteries and spoke of the E.P.S. cells and the Union cells. He pointed out that a low tension current required large and costly conductors, while a very small wire sufficed to carry a high-tension current. The use of transformers was then described and illustrated : by the use of these instruments high-tension currents brought from a central station by small wires were transformed down to low-tension currents at their entrance into houses, and thus risk was avoided. He then went into the question of overhead and underground conductors and the distance limits of the distribution of electricity, which could be set down practically as not exceeding two miles for commercial working, and probably nearer one. In reference to arc lamps, these had improved very much in steadiness, but the Brockie-Pell was the best, as being practically perfectly steady. As to glow lamps, their construction was briefly explained, and attention was called to their improved light and the greater number of hours they lasted. With reference to London lighting by arc lights, probably most had been done by the Brush Company, who thought that as to semi-public lighting of a permanent character there was no better instance than Charing-cross Railway Station,

which had been lighted from their works on the opposite side of the river for the last six years; also Liverpool-street, Waterloo stations, and the South Kensington Museum, in which last place, according to the official reports, the cost of gas each year would have been more than double. In the Colonial Exhibition the Company had 160 arc lamps, 18 in the garden, and 16 for the fountains. Negotiations were going on between that Company and the Corporation for the lighting of a very large area in the City of London. The Thomson-Houston system was rapidly gaining ground, and was worked by Messrs. Laing, Wharton and Down. At the American Exhibition they had 285 two thousand candle-power lamps, and there was not a hitch the whole time of the Exhibition. Longer established and nearly as large was the Gülcher Company, which had had 125 two thousand candle lamps at the Crystal Palace for nearly four years, and they now had 40 arc and 200 incandescents at the Aquarium, and 68 arc at the Olympia. For alternating current arc and glow lighting, Paddington Station installation, visited in October by the Society, and the Grosvenor Gallery were almost the only examples. In incandescence lighting, driven without accumulators, they had the Brush Company supplying the Grand, the First Avenue, and the Métropole Hotels, and many thousand lights in different parts of London. The Gülcher Company made a speciality of supplying photographers with electric light for their work. The Maxim-Weston Company were putting down in the north of London a large installation of fifty arc lamps and 400 incandescents, which when complete would be the largest, or one of the largest, private installations in the suburbs. They were negotiating about a central station in the city, and the manager of their works said:—"I can assure you that the electric lighting industry, in my opinion, never looked brighter than it does at the present moment. If the prospects improve in the same ratio as they have done in the last four months, there will be a very wide field next year." Messrs. Woodhouse and Rawson had lighted many printers' and large shops, such as Shoolbred's. A typical instance of domestic lighting, by Messrs. Woodhouse and Rawson, was the house of a well-known surgeon, who had 40 lamps specially arranged for lighting pictures as well as for making examinations of the eye with the opthalmascope, and the cost of gas for driving the engine for one year was £12. The same firm had carried out a curious installation in the sewage tanks at Crossness pumping station, which had to be cleaned out every twelve hours, and in which the atmosphere was so bad that candles burnt with difficulty. Referring to the lighting of theatres, the lecturer thought it essential that in any theatre the light should be put in two circuits entirely distinct, so that if anything went wrong in one, the place would not be in darkness, and so a panic would be avoided. A large installation of 5,000 lamps was being put in a large building in Whitehall, and a new system of distribution was being tried there by Mr. J. E. H. Gordon. As to installations in which accumulators formed a necessary part of the system, in the city the E.P.S. Company had more than 3,500 lights, and the use of accumulators was indispensable, since gas engines were nearly always employed, and when they are employed the light direct from the machinery was irregular. Among the prominent installations of this company were mentioned the Royal Society, the Bank of England, Lloyd's, offices of the P. and O. Company, and six banks. The largest thing Messrs. Drake and Gorham had done was the Prudential Insurance Company, with 2,500 lights, and when complete there would be 500 horse-power available, and 528 accumulator cells all in and for one building. After three years' trial the Bank of England were extending the lighting to all their principal offices.

The latest development was at the central station at Kensington Court, established by Messrs. Crompton and Co. It was the first station in London under the Electric Lighting Act, and it was extremely satisfactory in its financial results, the shares being now at 50 per cent. premium; and the company had decided to apply for powers to extend it over a very large area, comprising nearly the whole of Kensington, Knightsbridge, Brompton, and a portion of Chelsea, probably altogether the richest portion of residential London. The great feature was the small size of the plant and the space occupied by it in proportion to the work done. There was a special kind and special arrangement of accumulators, owing to which at present the steam engine and dynamo were never run after midnight. The engine employed was Willans' triple expansion engine, probably the most economical known. The cylinders were approximately 6, 8, and 12 inches diameter. The engine drove the dynamo direct at 370 revolutions a minute, and taken off the coal bill it burned 3½lb. of coal per electrical horse-power per hour. The combined engine and dynamo stood on a space 9ft. by 4ft. 6in, and there were three of them, each of which gave a current of 250 amperes. There were two boilers, by Marshall, of Leeds, 15ft. long, 4ft. diameter, which burned from 60lb. to 70lb. of coal per hour. At present there were 1,000 lights supplied, and 500 more were contracted for, all in private houses, each with a meter. The farthest house at present lighted was 900 yards from the station, and Mr. Crompton believed that he could supply houses two miles off. At the Kensington Court station there was room enough to supply 20,000 lamps. The charge was 8d. per Board of Trade unit, which worked out to, if one wished to be exact, 0·28 of a penny, which was practically a farthing per lamp per hour. In conclusion, Mr. Carpenter said:—"Reviewing the whole of the evidence before us, it may fairly be said that the electric lighting industry has reached a stage in which the prospects of its very speedy development are decidedly good. As knowledge concerning it is gradually diffused the public becomes familiarised with the conditions under which alone it can be successfully carried out. The experimental step has passed. The days when electric lighting firms were glad to put up a temporary, and in some cases a permanent installation, at much less than cost price for the sake of advertising themselves and the light are, let us hope, gone for ever. The cases of failure of the light now are exceedingly rare, and I say advisedly that there is no case of failure known in which the cause was not thoroughly understood, and where it might not have been prevented beforehand by the expenditure of a little more money on the plant, or on the salary of a more competent superintendent, or on both. The mischief done by self-styled electricians, often so called merely from having fixed a few electric bells, is well-nigh insuperable. The fact, too, that a few years ago electricity was a name to conjure with on the Stock Exchange, and the means of enormous sums being lost with the gambling that went on there, shook public confidence to its foundation. I regret to say that even at the present day there are certain company promoters, connected more particularly with so-called new primary batteries, &c., against whom intending investors and others interested need to be put upon their guard. Only a few weeks ago a former pupil of mine told me he had been the means of preventing a sum of money, measured in tens of thousands of pounds, from being thrown away on one of these bubble schemes. The legitimate work is steadily increasing, and, not only in London, but all over the country, manufacturers are looking forward to a rapidly increasing business."

A brief discussion ensued, and a hearty vote of thanks was tendered to Mr. Carpenter for his interesting and exhaustive paper.

THE LIGHTING OF THE CITY.

At a meeting of the City Commission of Sewers, held at Guildhall on Monday last, Mr. Graham King presiding, a report was brought up from the Streets Committee submitting for adoption a proposed arrangement with the Anglo-American Brush Electric Light Corporation for lighting a district of the city by means of electricity. It stated that for nearly four years the committee had been in negotiation with that company in reference to various proposals for the electric lighting of a portion of the city on the principle of their being afforded facilities for lighting the private premises on their line of route, and they now submitted a draft contract for lighting the district commencing from the front of the Royal Exchange, and comprising so much of the city as lies between the Poultry, Cheapside, St. Paul's-churchyard, Ludgate-hill, and Fleet-street, on the north, and Queen Victoria-street and the Embankment on the south. It was proposed to have 169 arc lamps of 2,000 candle-power at £26 each per annum, or £4,394 in all, in place of 616 gas lamps costing £2,246, the total illuminating power of the arc lamps to be about 32 times that of the present gas lighting. In the narrow parts and courts glow lamps or arc lamps of less capacity and in greater number might be substituted at an additional cost of 50 per cent. and 25 per cent. respectively. The contract was for seven years, with power to the Commission to continue it for further periods of seven years so long as they did not grant to other companies powers in regard to private lighting within the district. The contract might be terminated after notice in writing of insufficiency of lighting and non-remedy by the Company for a month. The Commission would grant to the company the exclusive right to supply private lighting, and if they terminated the contract as to public lighting the company were to be at liberty to continue their private lighting.—Mr. J. C. Bell, in moving the adoption of the report, spoke of the great importance of the matter, and observed that unless the Commission gave some such stimulus as was proposed in the report electric lighting in the City must be inoperative for some time to come. The cost would not be more than twice the present cost of gas, while they would have thirty-two times more light. There was a very general desire on the part of the ratepayers for the introduction of the electric light, and the district in question would be lighted at a cost of not more than one-eighth of a penny in the pound to the rates. The city was well lighted as it was, but compared with Paris and other Continental cities, where the electric light was in use, it was very badly illuminated. The committee had earnestly considered the question of lighting the whole of the city, but the cost of lighting the small bye streets made it very expensive. No doubt they were creating a monopoly, but unless some such concession was given they could not hope to have electric lighting in the city.—Mr. W. H. Pannell, though strongly in favour of having the electric light, urged that some stringent forfeiture clauses should be inserted in the contract. The Commission had had some experience in the matter, and had seen their agreements with other companies used entirely for Stock Exchange purposes, without any consideration for the public interest. In the proposed agreement the company were to be at liberty to continue the private lighting, although they might not be able to continue the lighting of the public lamps, which it was admitted would be supplied at a loss to the company. Thus the company, immediately they obtained the monopoly, would have the power of repudiating their agreement to supply the public lamps. Again, the company would not be bound to supply all who desired to have the light, and they could charge exactly what they liked. He moved that the report be referred back to the committee for further consideration as to the points he had mentioned.—Mr. C. T. Harris advised the Commission to exercise particular caution in the matter.—Mr. F. Green remarked that if the chairman of the committee would consent to insert a forfeiture clause the Commission were practically agreed upon the report.—Mr. J. C. Bell, in reply, said they were bound to take some risk in the matter. He thought the fact that the company would have to expend a large sum in laying down their plant should be a sufficient guarantee. No company would consent to the insertion of a money penalty forfeiture clause. Electric lighting had been sufficiently handicapped by Act of Parliament without the Commission throwing obstacles in the way.—The amendment of Mr. Pannell was carried by twenty votes to eight, and the report was referred back for reconsideration.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions*

17,863. ROBERT HASWELL. Hartlepool. Producing electrical energy by means of the revolving axles of railway carriage wheels. December 29, 1887.

20. J. SHERRIN and J. VAUGHAN SHERRIN. Ramsgate. The entire or partial propulsion of bicycles, tricycles, and velocipedes by means of electromotors worked by primary batteries (complete specification). January 2, 1888.

39. E. TYLER. London. An improvement in voltaic batteries. January 2, 1888.

40. E. TYLER. London. An improvement in electrical block indicators for railways. January 2, 1888.

41. E. TYLER. London. An improvement in voltaic batteries. January 2, 1888.

50. D. J. MORGAN. London. Improvements in ships' lights in connection with ships' mechanical or electrical telegraph systems. January 2, 1888.

56. J. Y. JOHNSON. London. Improvements in the manufacture of the incandescing portion or luminant of incandescence electric lamps (Theodore Mace, United States). January 2, 1888.

80. J. R. THAME. London. Electro-mechanical automatic apparatus for the sale of merchandise. January 3, 1888.

100. H. H. LAKE. London. Improvements in and relating to apparatus for generating electricity (W. Humans, United States). (Complete specification.) January 3, 1888.

112. H. F. JOEL. London. Improvements in incandescence lamp holders and switches (Complete specification.) January 4, 1888.

115. S. W. BAYNES. London. Improvements in the insulation of electric appliances. January 4, 1888.

121. W. HORSFIELD, H. HIBBERT, and S. HORSFIELD. Nottingham. Electric tree tubs. January 4, 1888.

137. J. C. PURTHNER. Vienna. Improvements of the apparatus for producing inducted electric streams in the same direction (complete specification). January 4, 1888.

155. A. J. BOULT. London. Improvements in or relating to electrical turnstiles. (Otto Ehrling, Germany.) (Complete specification.) January 4, 1888.

208. O. C. DALHOUSIE ROSS. London. Improvements in the utilization of waste products from electrical batteries. January 5, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

January 7.

1,654. W. KINGSLAND. London. An improved method of closing or sealing secondary battery cells. February 2, 1887.

2,851. T. PARKER. Manchester. A new or improved automatic switch or cut-out for electrical circuits. February 24, 1887.

3,197. Sir D. L. SALOMONS, T. PARKER, and P. B. ELWELL. Wolverhampton. An improved means of separating the plates in secondary batteries. March 2, 1887.

3,469. C. A. MCEVOY. Southwark. Improvements in electric primers and mechanism for firing breech-loading guns. March 7, 1887.

4,478. C. MAYNARD. London. Improvements in the mode of, or means for, supporting or carrying telegraph or telephone wires or lines. March 25, 1887.

11,448. J. S. SELLON. London. Improvements in secondary batteries or electrical accumulators. August 22, 1887.

16,669. M. BAILEY and J. WARNER. London. An improved secondary battery combined with a miner's lamp. December 3, 1887.

16,728. A. HEINTZ. London. Improvement in the manufacture of incandescent electric lamps. December 5, 1887.

PATENTS SEALED.

December 30, 1887.

12,222. R. J. RUDD. Croydon. Electric apparatus for indicating time. September 25th, 1886.

893. G. W. HOOK. Wood Green. An electrical billiard marking repeater and indicator. January 20th, 1887.

14,135. H. J. HAIGHT. United States. Improvements in electro-magnetic self-signalling, self-alarm, and self-recording thermoscopes. March 18, 1887.

January 3, 1888.

13,971. H. R. FISHER. London. An improved self-regulating electric portable battery and lamp. October 30, 1886.

16,440. W. J. MACKENZIE. Glasgow. Improvements in electric arc lamps. December 15, 1886.

16,662. R. P. SELLON, W. M. MORDEY, and C. E. WEBBER. Surrey. Improvements in means for automatically regulating electric generators. December 18, 1886.

16,942. J. D. F. ANDREWS. Glasgow. Apparatus for conversion of electrical currents. December 24, 1886.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

15,774, 1886—I. PROBERT. Electrical switches, &c. (Price 1s. 3d.)

1,741, 1887—S. SUDWORTH, and C. K. FALKENSTEIN. Making and breaking electrical circuits. (Price 8d.)

1,862, 1887—C. D. ABEL. (Dun and Hasslacher.) Secondary batteries. (Price 6d.)

1,929, 1887—C. D. ABEL. (Dun and Hasslacher.) Galvanic batteries. (Price 4d.)

1,952, 1887—A. F. DEWAR, and F. WILSON. Electric switch. (Price 8d.)

1,993, 1887—E. HERMITE and others. Electrolysing bleaching solution (Price 11d.)

15,329, R. W. EDDISON. (McKnight.) Covering insulating electrical conductors with lead, &c. (Price 8d.)

The Patent Office has issued a notice to the effect that the official journal will in future be published weekly (on Saturdays) instead of bi-weekly as heretofore. Various alterations will at the same time be made in the "name" and "subject-matter" indexes; five indexes hitherto published will now cease to appear. The effect of these changes is that in future our weekly record of "Applications for Patents" will only be brought down to the Friday previous to the date of publication.

COMPANIES' MEETINGS & REPORTS.

International Cable Company (Limited).

The first annual general meeting of this Company was held at the offices, 34, Nicholas-lane, E.C., on Thursday, the 29th ult., under the presidency of Mr. W. J. Thompson.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said: I appear before you as the Chairman of a Company which had a very warm reception at its start. We were quite prepared for opposition, as the many supporters of the existing companies were sure not to be friendly to our scheme, and certain parties thought themselves justified in casting ridicule upon it in the press; but having been engaged in this project now myself some considerable time, I must acknowledge the courtesy which I have experienced from all concerned in it, and though some people have made strong remarks they never cast any reflection on the directorate, and I may even go further and say that had they looked through other coloured glasses their verdict would have been with us. There is only one matter that I would further mention on this subject, and that is that some reference should be made to a remarkable letter which I think damaged this Company most seriously, and even at this time I cannot realise what the writer intended, or whether he really weighed in his mind what would be the effect of his words. The letter damaged this scheme; but you will hardly credit it, that the writer was at that time a Director, if not the Chairman, of a syndicate anxious to promote this scheme. We shall now ask your opinion as to what you wish us to do in this matter in future. We hold the opinion that the proprietor of a single share in the Company is as much entitled to his opinion as the holder of 100 shares. Had we studied our own ease and comfort we should have retired as soon as we found the public held back. We had large promises from Liverpool and Glasgow, which failed; but as there were large subscriptions from parties professedly anxious to see the scheme carried through, the Directors felt they should not resign as long as there was any appearance of success. They determined, however, that unless they could be satisfied that there were sufficient funds to carry out the scheme in its entirety, they would not risk the money of the subscribers, although there were frequent requests to commence. Certain foreign subscriptions proving doubtful was another reason for over caution. Your Directors have worked at their own personal cost, and hoped to the last, and our hope has not been abandoned. The promoters, on their part, met the different position most frankly, and consented to forego half their claims. A member of the Board offered at his own cost to put himself in communication with his friends in Paris. He went over, bringing the scheme to the notice of his friends. When there he made an arrangement with Count Dillon, and after this he went over at the request of the Board to Portugal and saw his Excellency Señor Aguilar, late Minister of Public Works, and obtained an important extension of the contract for the concession from twenty to forty years. There were minor concessions, and I may say you cannot too much thank him, though he requests that his name may not be mentioned. It will also be in the recollection of some of you that the British Government invited tenders for a

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cable from Halifax to the Bermudas. As this was part of our scheme and would have been a key to our cables, to which we felt we might look, we entered into negotiations on the subject, and we have every reason to believe that if the British Government had not subsequently determined to defer the tender it would have been given to this Company. Had it been so we should have been in a position to lay down our cable. However, the thing is not entirely dropped. An official from the General Post Office called last week on Mr. S. Thompson to know if the scheme was going on. If we had succeeded in this, we could have gone on and found funds sufficient for carrying out the entire scheme. Well, we have also had communications from America and Spain to work with the Company, but until the main question is settled we feel it would be needlessly taking up time to consider these questions. At the present moment, the increased cost of copper is unfavourable; but, on the other hand, there seems to be less desire on the part of the existing companies to continue the war of rates. Well, you must decide as shareholders what to do. Our position as Directors has been anomalous. We always desired to go on if we could, and fairly and honourably. If the shareholders wish us to continue in office, I think we shall be willing to remain for six months. If, on the other hand, you come to the conclusion to close operations, we shall be prepared to resign and give the seven days' legal notice for a meeting. We have the money subscribed lying at the bank at seven days' call, where it has been since we received it—excepting something less than £600 which have been required for expenses of office, secretary, &c. The Board make no charge, and as we have nothing more to add, I shall now be happy to hear your views.

Mr. Surén said it would be important to know how much money had been subscribed and how much paid in.

Mr. Fox replied that 21,000 shares had been applied for, and £8,344 paid on application, and £811 on allotment.

Mr. Surén asked how much per cent. the expenses would be on the capital paid in.

Mr. Fox: About 10 per cent.

Mr. Surén: Well, I think the sooner we wind up the better, and I move that the Company be wound up.

Mr. Dain: I second that. I never had a notice of the first meeting.

Mr. Sydney Thompson (the solicitor), said the first Directors were the shareholders, and they appointed the present Directors.

Mr. Dain: Perhaps you will tell us if there has been any other meeting of the shareholders?

Mr. Thompson: No, there has not.

The Chairman: There has been no change on the Board, except that Lord Brabourne has retired and Señor Aguilar has died.

Mr. Holroyd said he had a considerable sum at stake in this Company, and proposed that it should not be wound up. From his information about it he did not think that would be a proper course, and he did not see why it should not be carried on to a successful issue.

Captain Wood seconded the amendment that the Company be not wound up, adding that he did so on the understanding that the present Board should remain in office. He was sure the shareholders would loyally support them in every way. The remarks of the Chairman in regard to the concession from the British Government were very appropriate, though probably it would not be wise to disclose all that took place. In the case of the company going into liquidation there would inevitably be heavy expenses both in litigation and liquidation, and probably, instead of getting 90 per cent., they would only get 10 per cent. returned. In regard to the concession, if they put on a bold front to the Government, he believed they would get it.

Mr. Gribbon spoke in support of the amendment. He was strongly interested in the Company, and thought if the present Board remained in office another six months, there was every prospect of bringing it to a successful issue. With a little more patience, the Company might be made a success.

Mr. Pope said if any information could be given to the meeting which would lead to unanimity it would be an advantage. It seemed to him an absurdity, seeing that they had a concession from the Portuguese Government for 40 years that they should wish to wind up. He supported the amendment.

Mr. Surén said his idea was to save all they could, and he did not see that there need be any litigation.

The Chairman: We take it as your decided opinion that the Company should be wound up.

M. De Ricci: Gentlemen, by your kind permission I wish to testify to the wonderful way in which our Chairman has worked, and, in answer to the very proper question put by Mr. Surén as to the amount that would be returned to you, I desire to say that the sum mentioned by the Chairman does not anything like represent what has been actually spent in the matter. I myself have spent more than half of that. I should be glad to be relieved of the responsibility of bringing this matter to a satisfactory issue. Whilst some have their thousands in it I have only £500. We have already achieved considerable results, and if you think it advisable we will still persevere, and perhaps it might desirable to adjourn for a short period.

The Chairman: Before I ask you to vote, there has been one point referred to as to the possibility of litigation. That is a point I have not taken into consideration. When certain gentlemen subscribed for the concessions, we had guarantees that they would not call for the return of that money. How the law would affect us I do not know. I cannot add more. I will now put the amendment that the International Cable Company shall not be wound up.

Nine voted for the amendment and five against.

The Chairman: Very well, gentlemen, then the amendment is carried, that the Company shall not be wound up.

Votes of thanks to the Chairman and Directors were passed, and the meeting separated.

Eastern Telegraph Company (Limited).

The following is the report of the Directors for the half-year ended 30th September, 1887, to be presented to the thirty-first half-yearly ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, London, on Thursday, the 19th inst., at 1 o'clock:—

2. The revenue for the period amounted to £291,265. 13s. 3d., from which are deducted £79,936. 11s. 4d. for the ordinary expenses, and £34,102. 5s. 7d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £4,465. 4s. 8d. for income-tax, there remains a balance of £172,761. 11s. 8d., to which is added £559. 3s. 2d., brought from the preceding half year, making a total available balance of £173,320. 14s. 10d.

3. From this balance there have been paid:—

	£	s.	d.
Interest on Debentures and Debenture Stock	28,538	4	9
Dividend on Preference Shares	20,384	13	8
Two interim dividends of 1¼ per cent. each on Ordinary Shares	95,000	0	0
	£143,922	18	5

leaving a balance of £29,397. 16s. 5d., which is carried forward to the next account.

4. The revenue includes £15,600 dividend for the half year upon the Company's shares in the Eastern and South African Telegraph Company, and also £384. 4s. 5d. net receipts for the half year on the shares of the Black Sea Telegraph Company belonging to this Company. The cables of these companies are in good working order.

5. With some exceptions, the several sections of the Company's cables and land lines continue in good working order; but as the Company's system is duplicated, and in some places triplicated, the interruptions do not affect the revenue.

6. The new cable from Porthcurnow to Lisbon, Gibraltar, Malta, and Zante, referred to at the last meeting, was successfully laid by the contractors, the Telegraph Construction and Maintenance Company, and opened for traffic in October last.

7. The new cable steamer "Amber," built by Messrs. Napier and Sons, Glasgow, to replace the ss. "Volta," has been launched, and will shortly be ready for service.

8. The Directors have satisfactorily completed the issue of 4 per cent. Mortgage Debenture Stock, to replace the £450,000 5 per cent. debentures which fell due on August 1 last.

9. In accordance with the provisions of the Articles of Association two of the Directors, Sir John Pender and the Marquis of Tweeddale, retire by rotation at this meeting, and being eligible offer themselves for re-election.

10. The auditors, Mr. Henry Dever and Messrs. Quilter, Welton and Co., retire, and offer themselves for re-election.

The Direct United States Cable Company (Limited).

The following is the report of the Directors for the six months ended 31st December, 1887, to be presented at the twenty-first ordinary general meeting of the Company, to be held at Winchester House, 50, Old Broad-street, on Friday, the 20th inst., at 2 p.m.:—

2. The revenue for the half year (subject to revision on settlement with the French Company), after deducting out-payments, amounted to £23,002. 17s. 6d., against £19,603. 6s. 11d. (after similar deductions) for the corresponding period of 1886, being a difference of £3,399. 10s. 7d. in favour of the half year under review.

3. The working and other expenses for the same period, including income-tax, &c., amounted to £15,864. 18s., leaving a balance of £7,137. 19s. 6d. as the net profit of the half year, making with £5,004. 0s. 6d. transferred from the reserve fund account a total of £12,142. For the corresponding half year of 1886 the working expenses and other payments amounted to £16,354. 7s. 6d.

4. Interim dividends of 2s. per share each for the quarter ended 30th September, 1887 (paid 24th October, 1887), and for the quarter ended 31st December, 1887 (payable 24th January, 1888), together amounting to £12,142, have been declared.

5. After mature consideration by the Board, the Company's cables and station were removed, during October and November last, from Torbay to Halifax (N.S.), and that portion of the short cable which lay across "Brown's Bank" was taken up and relaid in deeper water to the southward of the bank. 101 knots of new cable were required for carrying out these operations, which were successfully performed by the Telegraph Construction and Maintenance Company with their ss. "Britannia." By the changes thus made it is expected that the interests of the Company will be largely benefited, and that the costly interruptions, formerly so frequent, will probably now be avoided. The cost of the whole work, including charter of the ship and cable expended, amounted to £22,827. 5s. 10d.

6. The test action brought by the Anglo-American Telegraph Company against La Compagnie Française du Télégraphe de Paris à New York, to enforce performance of the joint-purse agreements, was heard before the Paris Tribunal of Commerce on the 12th ultimo. The decision in the case has been postponed till the 9th instant. The Directors have now the satisfaction of being able to report that the decision of the Paris Tribunal was delivered on the 9th instant, adjudging the French Company to perform the joint-purse agreements, and condemning that company to pay 2,000 francs per day, from the 1st January, 1887 (estimated at £30,000), as damages for past breaches, and further mulcting it in the costs of the action.

7. With a view of affording additional facilities to the public, a joint (branch) office has been established by the associated companies at Broome-street, New York.

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8. The sixpenny tariff continues, but the progressive development in the traffic has not been maintained.

9. The Directors record with deep regret the loss they have sustained by the death of Lord Hawke, which occurred suddenly on the 5th December last. Lord Hawke had been a Director of the Company from the date of its reconstruction in 1877. The vacant seat at the Board has not been filled up.

10. The engagement of Mr. J. W. Fuller, late secretary and traffic manager, has been terminated in consequence of severe illness, to the great regret of the Board.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 6th inst. amounted to £4,491.

DIRECT UNITED STATES CABLE COMPANY.—The directors of this company have declared an interim dividend of 2s. per share free of income-tax, being at the rate of 2 per cent. per annum, for the quarter ended 31st December, 1887, such dividend to be payable on and after the 24th inst.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of December, 1887, amounted to £38,908, and to £40,539 in the corresponding period of 1886.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of December, 1887, amounted to £21,600; from 1st January to 31st December, 1887, £264,480; while for the corresponding months of 1886 and 1885 they were £258,600 and £284,720 respectively.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 6th inst., after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, amounted to £3,613.

THE "SUNBEAM" LAMP.—Messrs. Clarke, Chapman, Parsons and Co., of Gateshead-on-Tyne, inform us that the manufacture of the "Sunbeam" lamp will, on and after 27th inst., be carried on by the Sunbeam Lamp Company (Limited), Sunbeam Lamp Works, Park-road, Gateshead-on-Tyne, to whom the business has been transferred.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Jan. 11.	Business Done Week Ending Jan. 11. Highest.	Lowest.
Anglo-American	37½, 38½	37¾	37
Do. Preferred	62½, 63½	62⅝	61¼
Do. Deferred	13½, 14½	13⅝	—
Brazilian Submarine	11⅞, 12⅛	12 1-16	11⅞
Cuba	12¼, 12¾	12¾	12⅜
Do. Preference	18, 19	—	—
Direct Spanish	3¾, 4¼	—	—
Do. Preference	8½, 9½	9	—
Direct United States Cable	8⅞, 9⅛	8⅞	8⅝
Eastern Telegraph	11¼, 11½	11½	11⅜
Do. 6 per Cent. Preference	14¼, 14¾	14⅝	14⅜
Do. 5 per Cent. Debentures, 1899	106, 109	—	—
Eastern Extension	12⅜, 12⅝	12½	12⅜
German Union	9¼, 9¾	—	—
Globe Telegraph and Trust	5⅜, 5⅝	5 9-16	5⅜
Do. Preference	13¼, 13½	13⅜	13 5-16
Great Northern	13½, 14	13⅜	13
Indo-European	87, 89	—	—
London Platino Brazilian	4, 4½	4⅜	4¼
Reuter's	8, 8½	8	—
Submarine	135, 145	—	—
West Coast of America	4¾ 5¼	5¼	5 3-16
Do. Debentures	108 112	—	—
West India and Panama	¾, 1	—	—
Do. 1st Preference	9¼, 9¾	9⅜	—
Western Brazilian	9¼, 9½	9 1-16	8⅞
Western Union 7 per Cent. 1st Mortgage	120, 125	—	—
Do. 6 per Cent. Sterling Bonds	101, 104	—	—

TELEPHONES.

Companies.	Closing Prices. Jan. 11.	Highest.	Lowest.
Consolid. Telephone and Maintenance	9-16, 11-16	—	—
Oriental	¼, ⅜	—	—
United Telephone	11⅝, 12	12	11¾
United River Plate Telephone	4½, 5	5	—

ELECTRIC LIGHT.

Companies.	Closing Prices. Jan. 11.	Highest.	Lowest.
Anglo-American Brush Light (£3 paid)	2¾, 3¼	3	—
Do. (fully paid)	3¾, 4¼	4⅛	3⅝
Swan	1¼, 1⅜	1 5-16	—
Maxim Weston	3-16, 5-16	—	—

MISCELLANEOUS.

Companies.	Closing Prices. Jan. 11.	Highest.	Lowest.
Telegraph Construction	38, 39	38¾	38½
India Rubber, Gutta Percha and Telegraph Works	21½, 22½	22½	21¾

THE EASTERN TELEGRAPH COMPANY (LIMITED).

NOTICE IS HEREBY GIVEN, that the THIRTY-FIRST HALF-YEARLY ORDINARY GENERAL MEETING of the Eastern Telegraph Company (Limited) will be held on THURSDAY, the 19th JANUARY, 1888, at ONE o'clock in the Afternoon, at WINCHESTER HOUSE, 50, Old Broad-street, E.C., London, to receive the Directors' Report and Accounts, elect Directors and Auditors, and transact the ordinary business of the Company.

By order of the Board,
GEORGE DRAPER,
Secretary.

London, 9th January, 1888.

THE HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

CAPITAL £350,000

(with power to increase).

This Company is prepared to provide Residences, Offices, Clubs, Theatres, Hotels, Public Buildings, Churches, &c., with a supply of Electricity for Lighting purposes in any district where

FIFTY HOUSEHOLDERS COMBINE

to use the light.

PAST SUCCESSES.

Several of the founders of this Company have for some years past been working with success Central Stations for the generation and distribution of the Electric Current, for lighting purposes, in the towns of

BRIGHTON AND EASTBOURNE,

and, in view of the good results attained, they have determined to largely extend the field of their operations.

CENTRAL LIGHTING STATIONS.

The experience gained in these two towns proves that a Lighting Station, supplying even so small a number as 2,000 Incandescent Lamps, will yield a satisfactory return upon the capital employed in it, and

The Company will therefore be willing to lay down the necessary plant for a Central Station in any district from which applications are received from 50 householders, using a combined total of not less than 2,000 lights.

BOUND TO NO PARTICULAR SYSTEM,

the Company will start by using the system which has been perfected at Brighton and Eastbourne, but will hold themselves free to make use, from time to time, of the best methods known to carry out the production and distribution of electricity for lighting purposes.

The consumers will consequently have the advantage of the improvements that may be from time to time invented.

UNDER PERFECT CONTROL.

No machinery will be erected on the consumer's premises.

In order to obtain the electric light in the houses placed in connection with the Company's Central Stations, the occupier's servant will simply have to turn on a main switch or tap, just as the tap of a gas meter is now turned on, and the wires in the house will become instantly charged with electricity of low pressure *perfectly free from danger*, and the Incandescent lamps can then be turned on and off one by one as required.

METERS.

While the lamps are in use the quantity of the current consumed will be registered by a simple but perfectly efficient meter, PLACED LIKE A GAS METER ON THE PREMISES OF THE CONSUMER.

METHOD OF CHARGE.

Once a quarter the quantity of electricity registered by the meter will be ascertained, and the householder charged for the exact quantity consumed. If the lamps have been temporarily out of use no charge will be made, as then there will have been no consumption of current, and the leakage which so frequently happens when gas is out of use, is impossible in the case of the Electric Light.

COST OF THE LIGHT.

The quantity of current used in any particular house having been ascertained by meter, a charge will be made, as at Brighton and Eastbourne, of 1/- per Board of Trade Standard Unit (1,000 *watt-hours*), which is equivalent to a charge of about 6/- per 1,000 feet for gas.

In making this comparison it must be borne in mind that the use of the Electric Current can be greatly economised by the facility with which the lights can be turned out in unoccupied rooms.

There must also be set against the excess in cost the multitudinous advantages in the form of

PURITY,
CLEANLINESS,
COOLNESS,
CONVENIENCE,
STEADINESS,
BEAUTY,
SAFETY.

FORMATION OF CENTRES.

Those who are desirous of obtaining the Electric Light on the above terms should communicate immediately with the Company, so that steps may be promptly taken for laying down the necessary District Central Station.

Further particulars can be obtained on application to

HENRY ST. JOHN WINKWORTH,
Secretary,

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED,
117, BISHOPSGATE STREET WITHIN, LONDON.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 505.—Vol. XX. FRIDAY, JANUARY 20, 1888. Price 4d.

NOTES.

We print elsewhere a most interesting paper, lately read by Mr. Willard E. Case, before the American Institute of Electrical Engineers, on "Electric Energy from Carbon without Heat." We have taken the liberty, however, of altering the title to "Carbon as a Positive Element." Amongst other suggestive experiments, Mr. Case finds that when carbon is attacked by perchloric acid in the presence of platinum the E.M.F. obtained with different varieties of carbon ranged from 0·3 to 1·25volt, the higher values being due, as the author thinks, to the presence of oxygen condensed in the pores of the carbon. Mr. Case thinks that there is a promising field for experiment in this direction, and certainly it is an encouraging fact that the reaction yields an E.M.F. as high as 1¼volt. Perchloric acid is, however, a decidedly uncomfortable reagent to handle. The *pure* acid will set fire to paper, and causes an explosion when dropped on powdered carbon.

Twice in the course of his new book, "The English in the West Indies," does Mr. Froude complain of the untrustworthiness of the news transmitted by telegraph through the United States to the West India Islands. We have heard on the highest authority precisely similar complaints from Canada. Indeed, there can be no manner of doubt that political intelligence relating to England passing through the States on its way to British possessions is often—nay, almost invariably—edited so as to create alarm, panic, or indignation in the English Colonies. Mr. Froude is of course mistaken in ascribing this manipulation of the text to the New York Irish telegraph operators, whose messages he conjectures are "the creation of their wishes." Irish telegraphists are the best operators in the world, and we do not suppose that their professional fidelity is affected by their residence in New York. The real offenders probably are the news agencies. But whoever they may be, it is high time their command of the telegraph wires for purposes distinctly and deliberately hostile to this country should cease.

Mr. Higgins' letter on the use of platinum wire in firedamp indicators (in our last issue) is obviously of great practical importance, and should receive careful attention from all interested in the question. It is also a very curious contribution to our knowledge of the "catalytic" powers which platinum pre-eminently possesses. Mr. Higgins finds that after having been frequently heated in the gas platinum acquires the property of igniting the gases when not itself heated by the battery current, and of becoming incandescent and exploding the mixture when gas is present in explosive proportion. It would therefore appear necessary to discard platinum altogether for the purpose in view.

Our correspondent who, in another column, ventures to impeach the theoretical soundness of Mr. Stanley's views on "The Phenomena of Retardation in the Induction Coil," prefers an indictment which we feel bound to endorse; in fact, when the paper in question first came into our hands some weeks ago, we felt that on behalf of those of our readers who are commencing the study of a confessedly difficult subject we should have deserved little thanks for its publication. Mr. Stanley has achieved a splendid success in the practical application of alternating currents, and we most ungrudgingly recognise his claims to honourable distinction as a practical electrician. But for all this, he has not proved himself to be a competent expositor of the theory of alternating currents. His present paper, moreover, is not the only evidence on which we base this opinion. But, confining ourselves to this paper, we may note the following heresies: (1) That the self-induction of a coreless solenoid produces no retardation of phase. (2) That the retardation in a secondary circuit is necessarily equal to that of the primary (this is not asserted in so many words, but is assumed in the calculations). (3) That $C^2 R$ represents the loss of energy in the armature coils of an alternating-current machine. All which (and more) we "steadfastly deny."

Mr. Stanley describes an experiment due to Mr. Shallenberger which is of singular interest, but (without disputing its accuracy) we confess that at present it wholly baffles our comprehension. Mr. Shallenberger connects four 50-volt lamps in series across a circuit having a difference of potential of 200 volts. Each lamp is shunted by a coil having an iron core which is saturated when the potential at its terminals is equal to 100 volts. If one lamp be turned off, leaving its shunt coil still in circuit, a voltmeter measures 50 volts as before across the terminals of the three lamps still alight, while across the remaining shunt it now reads 100 volts, giving a total difference of potential, as thus measured, of 250 volts. But the series of three shunted lamps and one coil measured all together reads only 200 volts as before. These are the facts derived from Mr. Stanley's paper, but we can offer no ex-

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planation. Next week we hope to describe a practical device of a novel and highly ingenious description in the distribution of alternating currents which has been introduced by Mr. STANLEY with perfect success.

IN a lecture recently delivered before the Franklin Institute Prof. HAUPT has been astonishing the American world by his calculations on the savings to be effected by rapid transit. He calls the results "intensely practical," and insists that the prosperity of a community is fostered by recognising the facts he discloses. We do not feel quite so sure about it ourselves; but our readers can judge. By doubling the velocity of the street cars in Philadelphia half an hour might be saved for each passenger, and a saving of 23,148 years would annually be effected on the aggregate passengers using the cars. At first we were inclined to suggest that the passenger would save his time altogether by not taking the ride. But the curious professor assumes that everybody must ride or walk, and he evidently is dead against walking—a method of locomotion which involves a loss in New York computed at 8,333,333 horse-power energy per annum. To effect a large economy in this item he proposes to create fresh thoroughfares, cutting through the existing blocks diagonally. It strikes us that this would drive many people out of their homes and compel them to live farther away from their occupations, a result doubtless profitable to the street cars, but not to the inhabitants. After all, perhaps, both as regards the time saved in riding, and the energy saved in not walking, everything depends on what you do with the savings.

IT is difficult to attach much credence to the story which has been making the round of the press as to the cases of "sunstroke" said to have been caused by the electric furnace at the Creuzot works. Electric furnaces are scarcely novelties, and had such an effect been possible we should have expected to hear of it before this.

IF the thermo-magnetic generator should in the future prove to be an economical source of electric energy, it will be a matter of some regret that our English electricians have not taken a more prominent part in its development. But we shall at least have the satisfaction of knowing that the earliest investigations—so far as our present knowledge goes—of the conversion of heat into electrical energy by means of the thermo-magnetic properties of iron were carried out in this country. In another column will be found a reprint of a paper on this subject communicated to the Royal Society by Dr. G. GORE in 1869. It will be seen that the experiments are of a very simple and very beautiful character, and so suggestive that it appears strange that they should have remained on record all these years without bearing fruit. It is also interesting to know that eleven years earlier, in 1858, Dr. GORE had made some experiments in the same direction, though without results. In these earlier attempts a vertical tubular magnet was surrounded with a coil of insulated wire connected with a distant galvanometer. Into the axial cavity of the magnet red-hot sand was suddenly poured. However, as no result was attained the experiment remained unpublished.

IF any justification were needed for our remarks last week on the subject of Electricity and the Medical Profession, surely it is abundantly supplied by an article in the *Lancet* of Saturday last "On the Electrical Basis of Vital Motion." The author is a personage of no less distinction than Dr. C. B. RADCLIFFE, F.R.C.P. (Consulting Physician to the Westminster Hospital, Physician to the National Hospital for the Paralysed and Epileptic, &c.). Dr. RADCLIFFE expresses an opinion that the electrical phenomena displayed by nerves and muscles are the results "not of any electrical action confined to the muscular system, *but of an electrical action extending to the whole solar system and not limited to it.*" (!)

BEFORE proceeding to quote further from this paper, it will be well to remind those of our readers who may not be familiar with the *facts* of electro-physiology, that some forty years ago Du Bois Reymond discovered that if a living muscle be cut transversely across, a difference of electric potential may be shown to exist between the *end faces* and the sides of the muscle; but this phenomenon ceases with death. It is to explain these facts—admittedly difficult to understand—that Dr. RADCLIFFE invokes the electrical energies of "the whole solar system." The paper winds up with a discussion of the causes of "epilitiform convulsion," on which we do not presume to offer an opinion; but as for the passage which we quote at length below, we do not hesitate to pronounce it hopelessly fallacious and utterly unscientific in form. In fact, the method of argument (?) is more closely akin to that of the Schoolmen of the Middle Ages than to the recognised inductive methods of modern science. We shall not, however, try the patience of our readers by any detailed criticism, and we trust it will be understood that we write this not at all in the spirit of captiousness, but in the hope that the members of a learned profession which to-day, as always, numbers in its ranks some of the ablest workers and most careful thinkers of the age, will see to it that the exploration of the borderland of electricity and physiology shall be conducted in a manner worthy both of their profession and of ours.

AFTER the sentence already quoted the writer in the *Lancet* proceeds as follows :—

"At spring-tide and at neap-tide, when the action of the sun and moon are most differentiated, there are variations in terrestrial heat which show very plainly that the moon as well as the sun is directly concerned in producing these variations. There are variations in terrestrial magnetism at the same time which as clearly tell the same story. And there are cotemporaneous variations of the same sort in atmospheric potential, only as yet not so clearly made out as the variations in heat and magnetism. And the deficiency in the evidence here is supplemented by the presence of the belt of terrestrial magnetism, and by the requirements of the doctrine of the correlation of the physical forces : by the presence of the belt, because the very existence of magnetism is inconceivable apart from electricity ; by the requirements of the doctrine, because these oblige me to regard heat and light, and electricity and magnetism, and the other forms of physical forces, as mere modes of one and the same force. Indeed, there is, as I have attempted to show elsewhere, good reason to believe that the earth is continually acted upon by electricity which has its source in an electrical interaction which is always going on between the sun and moon on one hand and the earth on the other, and that this elec-

tricity is manifested in the form of currents across the earth from the sun and moon, the case being really one in which it is easy to believe that the dielectric sheaths of the fibres in nerve and muscle may be charged, as Leyden jars are charged by these currents, and that this charge will be instantly renewed after discharge. Nor can it be said that these currents are not powerful enough to do all this, for, as atmospheric potential is equal to several hundred volts at a short distance above the earth, and to still more than this as this distance increases, and as the directive power of the terrestrial magnetism is not altogether annihilated by the most powerful artificial magnetism, it is only fair to conclude that the solar and lunar currents are powerful enough to do all the work they have to do in charging the sheaths of the fibres in nerve and muscle, as Leyden jars are charged, and in instantly renewing this charge after discharge."

THE singular unanimity of opinion, both in this country and America, which found emphatic expression at the Eastern Telegraph Company's meeting yesterday, with regard to the honour recently conferred upon the Chairman of that Company, is perhaps the more justifiable from the fact that K.C.M.G. is usually a Colonial distinction, and seems to point in this instance to Sir John Pender's services in connection with the Colonies. What the British cable interests would seem to desire, and very naturally, is a recognition in some more appropriate form of Sir John's immense services to the country and the world in founding and developing British Submarine Telegraphy.

Copper.—After several fluctuations during the week copper fell considerably, Chili bars being yesterday quoted as low as £75. 2s. 6d.

Japan.—The electric light is becoming increasingly popular in Japan. A number of plants have recently been fitted up at Sakamotocho and Kyabacho.

Postponement of Sale.—The sale at Tufnell Park Mills, advertised to take place on the 25th inst., has been postponed till further notice (*see* our advertisement columns).

Postal Telegraph Appointments.—Mr. J. Murray, the clerk in charge of the telegraph office at Wick, has been appointed postmaster of that town, and Mr. M. Tuohy, telegraphist at Mallow, has been appointed postmaster of Bandon.

The Electro Harmonic Society.—The next smoking concert of this society will be held at St. James's Hall on Friday evening next, Jan. 27. We would direct the attention of our readers to the programme, which will be found in another column.

The New York Electric Club.—The new premises of this club will be formally opened on Tuesday evening, January 31st, when Prof. H. A. Rowland will deliver an address. We offer our hearty congratulations to the club on this auspicious occasion.

Tunbridge Wells.—At a meeting of the Tunbridge Wells Tradesmen's Association on Tuesday it was stated that a company was being formed to supply the electric light in the town. The tradesmen unanimously adopted a resolution favouring the introduction of the light.

Turin.—MM. Bellani, of Turin, have secured the rights of the Thomson-Houston system for Italy. This firm has maintained 30 arcs of 2,000 candle-power in one of the main streets of Turin during the last six months. The Thomson-Houston system is also represented in Italy, at Milan, and at Palermo.

Proposed Telephone Line from Brussels to Cologne.—Notwithstanding the fact that the German Government recently interdicted the use of existing telephone lines crossing the French and Swiss frontiers, they are, it is stated, inclined to sanction a project for laying a line between Brussels and Cologne, and it is believed that the work will shortly be undertaken.

The Electric Motor in Building Operations.—At Topeka, Kansas, several Sprague motors are in use for raising bricks and mortar, &c., upon the scaffolding of a large building in course of erection. Current is obtained from a neighbouring central station. The method proves to be much more economical than that of the employment of a steam crane, because the work is essentially of an intermittent description.

Leamington.—We regret to record that some trouble has arisen at the Leamington Central Station owing to an intermittent short circuit which has established itself somewhere in the mains, and had up to a few days since defied detection. A number of lamps had in consequence been cut out of circuit. The matter came before the Town Council, when a letter was read from Mr. Arthur Chamberlain expressing a hope that a permanent cure would be effected in a few days.

Ireland.—Telegraphs for Coastguards.—The staff of Engineers employed by the Irish Board of Works have received instructions to furnish as speedily as possible estimates of the cost of establishing telegraphic communication between the several Coastguard stations around the coast of Ireland. This step is being taken with a view to increasing the efficiency of the existing arrangements for detecting the landing of contraband articles, as well as with a view to strengthening the coast defences.—*Standard.*

The Observation of Earth Currents.—In accordance with an engagement entered into by the Spanish Government at the International Congress of Electricians held at Paris in 1881, two telegraph wires are about to be laid in Spain for the express purpose of making observations on earth currents and on atmospheric electricity. One of the lines will run due north and south, and the other due east and west, each line being eight kilometres in length. They will cross each other at the astronomical observatory of San Fernando.

Mill Lighting.—As an instance of the rapidity with which the electric light may sometimes be installed, Messrs. W. R. Dell and Son, of 26, Mark-lane, London, E.C., inform the *Miller* that, in the case of Mr. Cole's mill at Lipton, the light was working within a fortnight from the date on which they received the order. A very brisk business with electric lighting is reported by Mr. Wilson Hartnell, of Leeds, who states that he has just completed a mill at Penzance belonging to Messrs. Bageley and Sons. He has in hand also a 250 installation for Messrs. Reynolds, of Haslegrave, Wakefield, who have had one of Mr. Wilson Hartnell's installations at work for the last four or five years.

The Hanover-square Electrical School.—A handsomely got-up pamphlet describing the objects of this well-known establishment has just been issued by its managers. The school, which began 20 years ago by teaching ordinary telegraphy, soon developed into an institution for training superior operators, mainly for submarine cable work, but of late years has extended its aims to the teaching of electrical engineering. In all three departments its success has been conspicuous; and in combining the practical with the theoretical side of its tuition, "The School of Electrical Engineering and Submarine Telegraphy," in Princes-street, Hanover-square, occupies a quite exceptional position among the higher educational establishments of the country.

"Anti-Pulsator" for Gas Engines.—Messrs. George Bray and Co., the well-known gas engineers of Leeds, are introducing

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a simple apparatus, which they call an "anti-pulsator," intended to obviate the irregularities of working of gas engines, when due to variations in the pressure at which the gas enters the compression cylinder. There is no doubt that such variations of pressure are often the sole cause of the complaints arising from the unsteadiness of gas engines when employed for the electric light. Messrs. Bray state that with their apparatus it is possible to supply gas burners from the same meter as that used for the engine without causing any unsteadiness in the light. The "anti-pulsator" appears to be well worth the attention of electric light engineers.

Electric Locomotives on the Underground Railway.—The *Globe* now announces that the arrangements, which we foreshadowed some weeks ago, have been completed between the Metropolitan Railway Company and the Electric Traction Company for experimental running upon a section of the railway outside the circle of a locomotive of the same power as the present steam locomotive. The Electric Traction Company stipulate that should the experiment prove an advantageous and economical method of working, they are to have the option of entering into an agreement for working the railway by electricity for a term of five years at a rate per train mile to be agreed, such rate not to be in excess of the cost of working by means of steam locomotives.

The Mexican Telegraph Company.—The New York correspondent of the *Mexican Financier* reports the substance of an interview with Mr. Scrymsek, the President of the Mexican Telegraph Company, in which reference is made to the steady improvement of business over that company's lines. This is attributed to the increased commercial development of the Republic; to the improved condition of the Government lines, to which we referred some time ago; and to the greater use of telegraphy by merchants in remote parts of the Republic. Attention is also drawn to the accuracy of the service over the lines of the Mexican Telegraph Company. It is stated that in a total of 170,000 words transmitted in September last (presumably to New York) only ten errors were made, while in October there were again but ten errors out of a total of 180,000 words transmitted.

The Burmese Telegraphs.—The *Indian Engineer* says:—"We are glad to be able to state that Mandalay will soon be in direct telegraphic communication with Calcutta. The work of laying down the different sections of the line has already been begun. The line between Mandalay and Alon has been complete; that from Alon to Myingyan is now being laid under the supervision of Mr. G. O'Hara, sub-assistant superintendent; the second line from Myingyan to Kendat will be laid by Mr. Whitby Smith, assistant superintendent; and a third section from Kendat to Thaumboo, a station not far from Manipur, in Assam, whence the whole extension to Calcutta will be completed, the whole of the line being constructed in five or six months. The parties who are to go out on the work of construction will be escorted by armed troops consisting of 25 or 30 men or more, the numbers depending on the state of the country through which a party may have to pass, these regions being at present infested by dacoits."

Bath.—The second meeting of the Electric Lighting Committee of the Bath Town Council took place on Thursday at the Guildhall. The chairman said he had much pleasure in laying before the committee the information asked for at the last meeting. With a view to obtaining it from the most reliable and independent sources, he had written to the scientific and technical papers devoted to electrical engineering, asking in what towns in the United Kingdom the electric light had been adopted, and in what places it had proved successful, or been abandoned. After a long discussion it was pointed out that all agreed that the most successful installation was the one at Taunton, and the town clerk was requested to put himself in communication with the town clerk of that town, and ascertain particulars respecting the system in use there, and report the result of his inquiries at the next meeting.

The West Coast of Africa Telegraph System.—A correspondent writes from Accra:—"In the course of his speech to a large assemblage, composed of native kings, chiefs, merchants, and others at Accra, his Excellency (Sir W. Brandford Griffith, K.C.M.G., Governor of the Gold Coast Colony) referred in eulogistic terms to the advent of the cables of the West African and African Direct Telegraph Companies. He said we had much to be thankful for to these companies in establishing their lines of communication to this colony, for there can be no doubt that they have considerably helped to bring civilisation and promote competition in trade, which can only tend to improve its condition; and these companies were conducted by gentlemen of intelligence and culture, combined with social qualities of a high order, and they had, moreover, erected buildings of architectural designs worthy of themselves, and which he hoped would be followed as an excellent example."

An Electric Sentinel.—Mr. Daniel Drawbaugh, whose name is well-known in connection with telephone suits in the United States courts, has devised an apparatus which he proposes to employ in connection with military operations as an automatic sentinel. The apparatus is to be buried in the earth at the outposts, and connected by an insulated wire with head-quarters. According to the published descriptions—which are not of a very lucid character—the recording instrument appears to consist of a delicate relay, closing a second circuit through a mercury contact, and so actuating a registering mechanism. The relay is said to be operated by the disturbance of the current produced by a microphone contact which constitutes the transmitting apparatus. It is difficult to suppose that there is anything practical in this suggestion. Even if technical difficulties have been overcome, we do not see how the microphone is to distinguish friends from foes, or rabbits from human beings; and a sentinel who is unable to do this is evidently of very little use.

York.—Messrs. Rowntree, Hills and Co., of York, have recently lit their premises by electric light. The installation, which has been carried out by Messrs. J. H. Holmes and Co., Newcastle-on-Tyne, consists of one of their No. 8 "Castle" dynamos (compound wound), giving 70 amperes, 60 volts, at a speed of 1,000 revolutions, driven by a 6 horse-power "Stockport" gas engine. The shops are lighted by nine of J. H. Holmes "Castle" arc lamps, which received a silver medal—the highest award—at the Newcastle Exhibition, and five small ones, giving 400 candle-powder with a current of 5 amperes. The offices at the back of the premises are lighted with 60-volt Swan lamps. The arc lamps employed in this installation are of Messrs. Holmes and Co.'s new and improved type, including their recently patented arrangements for ensuring a definite feed, and thus regulating the lamps with great certainty. The creamery is elaborately panelled with decorated tiles, and the small arcs in this department give a charming effect.

The Lighting of the City.—The *City Press*, commenting on this subject, says:—"There can be but little doubt that we have been deprived of the proper use of this most brilliant discovery, for many years, by the blundering legislation proposed, and unfortunately carried into effect, by Mr. Chamber-

lain when one of Her Majesty's Ministers. He was so fearful of establishing a monopoly in the supply of electricity, similar to that existing in regard to gas, that he hedged round any attempt at a contract for public lighting with such stringent, not to say absurd, conditions that our streets have remained in the same condition of semi darkness as before, and now that, after so lengthened a consideration, a contract has at length been prepared that promises to give us the same beautiful lighting that we see with envious eyes elsewhere, we do most sincerely hope that the Streets Committee will be able to obtain such a modification of it in the way suggested by the dissentients as will remove what seems to be their one objection to its adoption."

Electro-Plating with the Dynamo.—A paper on this subject was lately read before the Electro-Technical Society of Vienna by Wilhelm Penkert. After an historical sketch of the subject from the first attempt in 1875 at the Austrian State printing office to the present day, the author gives some interesting hints from modern practice. For smaller baths earthenware, free from acid, is found the best; for larger sizes wooden baths lined with lead, which in its turn is covered with large glass plates, may be used, as the resin on the lead is found to have a bad effect on the deposit. The experiments carried out by Baron Hübl at the Military Geographical Institute were mentioned as showing that with a current density of 1·3 ampere per square decimeter (= ·084 ampere per square inch) in a bath of 20 per cent. solution of copper sulphate, with 3 per cent. sulphuric acid added, a deposit is obtained which is tougher than rolled and hammered copper, and almost as elastic, strong, and hard. Baron Hübl had also shown that the anode used is not composed of copper oxide, as formerly supposed, but of pure metallic copper.

A New Petroleum Engine.—A new description of petroleum engine, the invention of Mr. Shipman, an American, has been recently exhibited in this country. It is designed to burn any kind of liquid fuel, and to be as self-regulating in the use of this form of combustible as the gas-engine with coal gas. It is stated that this end is so far achieved that the engine works for hours with varying loads and without supervision; the fire and the water supply always adapting themselves to the work to be done. The oil runs from a tank into a pipe situated a few inches below the furnace. From this pipe it is drawn up by two atomizers fed with steam from the boiler; and in this way the furnace is fired. The steam supply to the atomizers passes under a diaphragm, to which a valve is attached; and as the diaphragm is loaded, so it cuts off or opens the passage for the flow of steam, according as the steam pressure rises or falls. Thus the steam can never rise beyond the determined pressure; because as soon as this limit is attained, the fire is extinguished. A pilot lamp is provided for lighting the fire again when the pressure falls sufficiently to open the valve. Practically, of course, the fire need scarcely be extinguished at all, for the consumption of oil can be adjusted to the average amount of evaporation required by the ordinary working of the engine. The water supply is also controlled by a float connected by a lever with a cock on the suction pipe of the pump. The boiler is of peculiar construction, being rectangular, with a cluster of blind tubes projecting from one side among which the heat circulates. The consumption of fuel is stated to be about three pints per indicated horse-power per hour.

Spanish Telegraph Statistics.—The general Board of Posts and Telegraphs in Spain have just issued the telegraph statistics for the second half of 1886. The publication of such statistics after the lapse of twelve months may seem late, but a leading Madrid paper says that the delays in compiling official statistics in Spain are so great that it is a matter of congratulation that they should have appeared so soon. It appears from the statistics that at the 31st December last the length of overhead telegraph wires in Spain was 18,419 kilometres, underground wires 144 kilometres, and submarine wires 236 kilometres. The number of despatches during the six months, distinguishing internal and foreign, private, public, and service messages, was as follows:—Interior—Official, 186,453; service, 53,508; private, 1,176,507. Foreign—Official, 6,100 messages despatched and 4,383 received; private, 180,952 sent and 202,826 received; and transit messages 50,593. The revenue amounted to £134,270. The total number of messages for the twelve months ended 31st December last was 3,549,860, of which 801,656 were international, and 2,748,204 were internal. Of the latter 372,407 were official, 108,323 were service telegrams, and the rest—2,267,574—private. The year's receipts were £237,515, and the expenditure £308,440, in the proportion of £195,025 for *personnel*, and £114,415 for lines, stations, &c. There was, therefore, a deficit for the State of some £70,925. The Spanish telegraph service certainly seems to be going from bad to worse as a source of revenue. The *Dia* of Madrid, commenting upon the result, says that four years ago, viz., in 1882, the length of lines was 16,744 kilometres, and the total cost was £193,875. Since then the addition to the wires has only been 1,675 kilometres, but the expenditure has increased by some £114,565, while the revenue has increased £40,790. It would therefore appear that the Spanish telegraph service, which was profitable in 1882, has now become a serious loss to the State.

A New Departure in Brazing and Welding.—Mr. Fletcher, the well-known gas engineer, writes us as follows:—"The cheapening of oxygen by Brin's process of manufacture has put into the hands of metal workers a new power. I have recently made a few experiments with the compressed oxygen and coal gas, and found that with a ½in. gas supply a joint could be brazed in a 2in. wrought-iron pipe in about one minute, the heat being very short, the redness not extending over 1in. on each side of the joint. The appearance of the surface after brazing led me to experiment further with welding, a process which is not possible with ordinary coal gas and air, owing to the formation of magnetic oxide on the surfaces. Contrary to my expectation, a good weld was obtained on an iron wire ⅛in. diameter with a very small blowpipe, having an air jet about $\frac{1}{32}$in. diameter. This matter requires to be taken up and tried on a large scale for such work as welding boiler plates, which, it appears to me, can be done perfectly with far less trouble than would be required to braze an ordinary joint. The great advantage of this would be that the boilers would require no handling, but could be welded with an ordinary large blowpipe in position, and with about one-tenth the labour at present necessary. The cost of the oxygen is trifling, and it is evident from the results obtained in brazing that the consumption of gas would be considerably less than one-fourth that necessary with an air blast, irrespective of the fact that welding is possible with an oxygen blast, whereas it is not possible if air is used. The surface of iron heated to welding heat by this means comes out singularly clean and free from scale, and a small bottle of compressed oxygen with a blowpipe and a moderate gas supply would make the repairs of machinery, boilers, brewing coppers, and other unwieldy apparatus a very simple matter. The trouble and difficulty of making good boiler crowns, which so frequently come down, would be very small indeed when the workman has an unlimited source of heat at command, under perfect and instant control."

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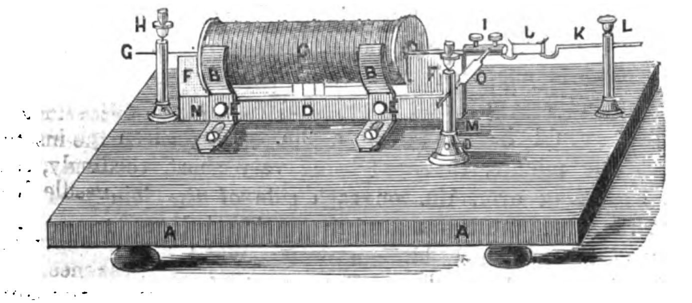
EARLY RESEARCHES IN THERMOMAGNETIC GENERATORS.

Nearly twenty years ago some experiments were brought before the Royal Society by Dr. G. Gore, F.R.S., in which the principle of the thermomagnetic generator is fully exemplified. The paper will be found in the *Proceedings Roy. Soc.*, Vol. XVII., p. 261, 1868–9, and also in the *Phil. Mag.*, Vol. XXXVIII., p. 60, 1869; under the title, "On the Development of Electric Currents by Magnetism and Heat." The subject having now entered upon a further stage of development, we reproduce here the figure illustrating the experiments, together with an extract from Dr. Gore's paper as follows.

"I have devised the following apparatus for demonstrating a relation of current electricity to magnetism and heat:—

"A A, Fig. 1, is a wooden base upon which is, supporting four brass clamps (two, B B, on each side), a coil of wire, C; the coil is 6in. long, 1½in. in external diameter, and ⅜in. internal diameter, lined with a thin glass tube; it consists of 18 layers, or about 3,000 turns, of insulated copper wire of 0·415mm. diameter (or size 26 of ordinary wire gauge); D is a permanent bar magnet held in its place by the screws E E, and having upon its poles two flat armatures of soft iron, F F, placed edgewise. Within the axis of the coil is a straight wire of soft iron, G, one end of which is held fast by the pillar screw H, and the other by the cylindrical binding screw I; the latter screw has a hook to which is attached a vulcanised india rubber band, J, which is stretched and held secure by the hooked brass rod K and the pillar screw L. The screw H is surmounted by a small mercury cup for making connections with one pole of a voltaic battery, being secured to the pillar screw M, which is also mounted by a small mercury cup, and is connected with the cylindrical binding screw I by a copper wire with a middle flattened portion, O, to impart to



it flexibility. The two ends of the fine wire coil are soldered to two small binding screws at the back; those screws are but partly shown in the sketch, and are for the purpose of connection with a suitable galvanonometer. The armatures F F are grooved on their upper edges, and the iron wire lies in these grooves in contact with them; and to prevent the electric current passing through the magnet, a small piece of paper or other thin non-conductor is inserted between the magnet and one of the armatures. The battery employed consisted of six Grove's elements (arranged in one series) with the immersed portion of platinum plates about 5in. by 3in.; it was sufficiently strong to heat an iron wire of 1·03mm. diameter and 20·5 centimetres long, to a low red heat.

"By making the contacts of the battery in unison with the movements of the galvanometer needles a swing of about 12deg. of the needles each way was obtained. The galvanometer was not a very sensitive one; it contained 192 turns of wire. . . . The maximum effect of 12deg. each way, with six Grove's cells in one series was obtained, when the wire became visibly red hot, and this occurred with an iron wire, 1·03mm. diameter (or No. 19 of ordinary wire gauge). By employing a thicker wire and a battery of greater heating power, still greater effects were obtained. The galvanometer was placed about 8ft. (in some instances 12ft) distant from the coil. A reversal of the direction of the battery current did not reverse or perceptibly affect the current induced in the coil; but by reversing the poles of the magnet the direction of the induced current was reversed. On disconnecting the battery, and thereby cooling the iron wire, a reversed direction of induced current was produced. By substituting a wire of pure nickel, 24·5 centimetres long and 2·1mm. in diameter, induced currents were obtained as with the iron, but they were more feeble. No induced current occurred by heating the iron wire if the magnet was absent; nor was any induced current obtained if the magnet was present, and wires of palladium, platinum, gold, silver, copper, brass, or german-silver were heated to redness instead of iron wire; . . . it is evident, therefore, that the axial wire must be composed of a magnetic metal. . . .

"The direction of the induced current by *heating* the iron wire was found by experiment to be the same as that which was produced by removing the magnet *from* the coil; and therefore the heat acted simply by *diminishing* the magnetism, and the results were in accordance with, and afford a further confirmation of, the general law, that wherever there is increasing or decreasing magnetism, there is a tendency to an electric current in a conductor at right angles to it."

(To be continued.)

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

(Continued from page 235.)

CHAPTER VI.—*Current Indicators (continued).*

66. As regards telephone circuits and instruments, the detector is an indispensable item of an inspector's kit, who will frequently require it to detect any fault in his instruments or examine the condition of the batteries. The more portable, while reliable, of course the better, and some of the telephone companies have in use the pocket type described. As the batteries used are generally Leclanché's and the resistances met with rather under than over 50ω, the detector would be wound to that resistance or less, according to the resistance of the induction coils and receivers and the type of battery in use.

67. For dynamo or accumulator circuits where the resistances are very small, detectors for showing the direction of the

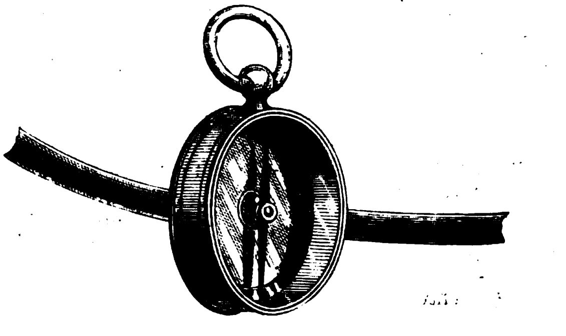


FIG. 27.

current or ascertaining whether it is constant, are in use and are wound with a few turns of thick wire to resistances from 1ω to $\frac{1}{100}$ω, or even less. In fact, with ordinary electric lighting currents, say from 10 amperes upwards, no coil is required at all as far as finding the *direction* of the current is concerned; an ordinary pocket compass placed over the main wire at any part of the circuit will show the direction of current at once. The compass-needle will try to set itself at right angles to the wire in which the current is passing. If the north pole of the needle turns to the *right* the current will be flowing *away* from the observer, and *vice versâ* (see Fig. 27). It will easily be seen whether the current is strong by the rapidity of the oscillations made by the needle when placed over the main wire; and if the current was a feeble one, causing very sluggish oscillations, as it would, under the influence of the earth's field alone, a portion of the main wire should be

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selected which lies north and south, or a few inches of it may be easily bent into this direction before applying the compass test; it can then be seen quite well towards which direction the needle tends to turn from the meridian, the earth's field tending to keep it parallel to the wire, and the field produced by the current tending to move it away from a parallel position.

68. On this principle an engine-room current indicator is easily constructed with a magnetic needle freely suspended over a single broad band of copper, the ends of which are attached to terminals outside the instrument. The writer recollects seeing an indicator of this kind, with a vertically-suspended needle placed where it could be readily seen, in the engine room at one of the London exhibitions. It was in the circuit of six arc lamps, which served to illuminate the grounds from the top of a high mast, and the dynamo attendant could see by it quite well whether his lamps were burning all right or one was failing. There being no bobbins or coils the instrument is extremely simple to make, and, if required, can be calibrated in amperes by comparison with some ammeter whose constant is known. One is illustrated in Fig. 28, the copper or brass band behind the needle being shaded, and the

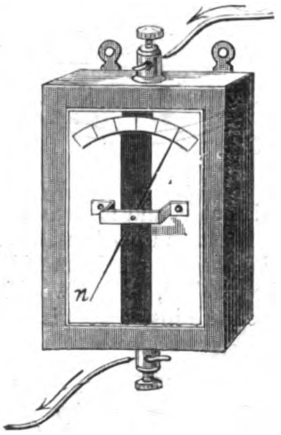


Fig. 28.

needle itself having its north end downwards. The direction of deflection for a given current is then that shown.

69. A question that will naturally suggest itself from the last few observations will be: Does not the current in the leading wires attached to a *measuring* instrument affect its readings? As a matter of fact it does with a weak controlling field, and the precaution must be taken of twisting the two leading wires as they approach the instrument, so neutralising the extraneous field they produce. If, however, the instrument has a powerful magnetic controlling field the effect is practically *nil*, and there is no necessity for the above precaution. In all cases, before readings are taken, it can be noticed whether, when the current is on, the leading wires affect the needle by shifting their position relatively to the latter and observing whether any alteration occurs in the number of degrees deflection.

70. Large telegraph stations and telephone exchanges have in use a large number of cells, in some cases of different types for local circuits or line work, and the battery man has to keep a spare set of cells ready to put on to a circuit in case any should "run down." In cable stations there are in addition sets of very low-resistance "tray" cells for magnetising the electro-magnets of the recorder instrument. An indicator with coils of different resistance for testing the condition of cells of different types is then a requisition. A form of indicator fitted in this way (by Messrs. Elliott Brothers) is shown in Fig. 29, the coils being respectively of 2, 10, and 1,000 ohms. Batteries or circuits to be tested are connected to the instrument at A and B, and the plug P is inserted in the hole opposite the number showing the resistance of the coil required. This arrangement of brass bars and movable plug is technically called a "commutator;" a plan of this portion is shown in Fig. 30 with the connections to the coils. The current can be made to pass from one terminal to the other through any of the coils by inserting the plug at the bar marked with its resistance. The high-resistance coil is wound with many turns of fine wire, and the two-ohm coil with a few turns of thick wire.

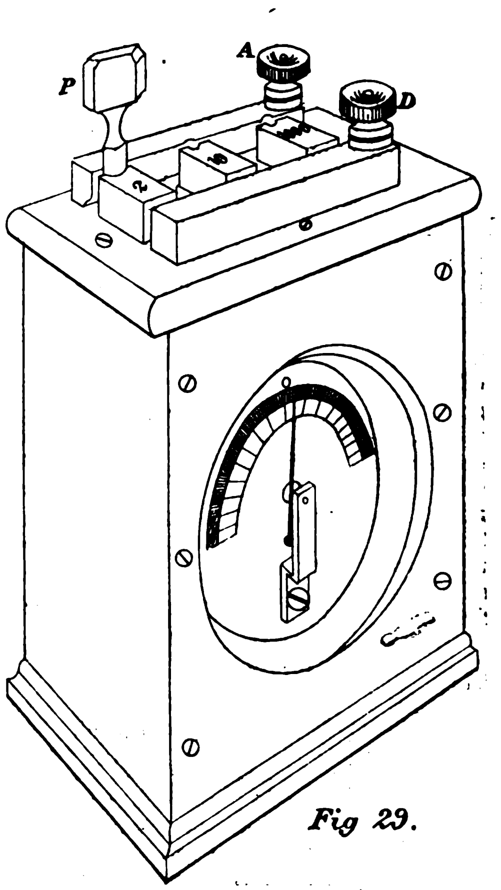
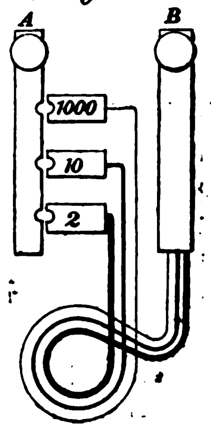


Fig 29.

71. Should the needle of a vertical detector lose its strength of magnetism to any extent the deflection given by the instrument with a given current will be weakened accordingly, but as the north pole is the weighted or lower end the needle lies in a favourable position as regards the earth's field in this latitude for maintaining its polarity, and it will probably be years before its magnetism becomes sensibly weakened. If strong currents, however, are put through the instrument,

Fig 30.



especially if the circuit is disconnected and connected several times in succession, the magnetism of the needle may become affected. This is the more noticeable in telegraph needle signalling instruments, which are connected to a long length of overhead wire. Atmospheric electrical discharges

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take place at times through the wire, and if the instrument protectors do not act, the needle may become partially demagnetised, or even have its magnetism reversed. Devices for preventing this will be considered later on in this series when telegraph apparatus is examined. The needle signalling instrument, however, is mentioned at this point because its internal construction is exactly the same as the vertical indicators which have just been considered.

72. When the needle of an indicator is pivoted so as lie horizontally, any weakening of its magnetism has very little effect on the sensibility of the instrument. The reason for this is that the controlling force, or force tending to maintain the needle at zero, is that of the earth's field, the actual amount of that force acting at each end of the needle being the product of the earth's field and the strength of one of the needle poles. On the other hand, the force exerted at each end of the needle by the current in the coils, tending to move it away from zero, is equal to the product of the field of the coil and the strength of one pole of the needle. Since both the moving force and the controlling force depend equally on the magnetic strength of the needle, the ratio between them is simply the ratio of the respective fields of the coil and the earth, and the needle will therefore take up a position depending on the relation between the two fields irrespective of the actual strength of the needle poles; unless, indeed, they are entirely demagnetised, in which case there would be no moving or controlling force at all, except, probably, irregular forces caused by magnetic induction.

The friction on the pivot, however, which is a negligible quantity when the needle is strongly magnetised, becomes an appreciable obstacle to its movement when its magnetism is weakened, for while the *relation* between the moving and controlling forces depends simply on the two fields, and therefore is unaltered by weakening the magnet, it will be seen by what was said above that the *actual amount* of these forces is proportionately reduced as the magnet becomes weaker, and that therefore the needle is not drawn towards or held in its deflected position with the same force and with the same facility of overcoming friction as when it is strongly magnetised.

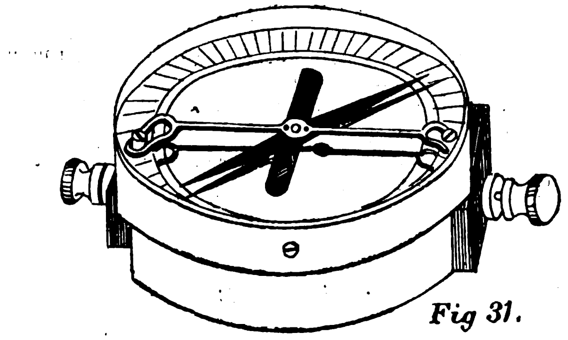

Fig 31.

The horizontal pivoting of needles, however, admits of very sensitive mounting of the needle spindle. Illustrated in Figs. 31 and 32 are two very sensitive indicators of this class by Messrs. Elliott Bros. In Fig. 31 the spindle joining the two parallel magnetic needles, whose opposite poles point the same way, is pivoted in jewel centres and constitutes an indicator that may be very well used with proper calibration for a number of useful tests requiring accuracy. The dial is about 3½in. diameter, and the coil is wound to $1,000\omega$ resistance.

There is only one magnetic needle in the instrument represented in Fig. 32, the pointer, which indicates the deflection, and is fixed at right angles to the needle, being non-magnetic. When the instrument is used the coils must be turned round until they lie in the same plane as the needle *n s* (*see* Fig. 33). Now, as it would be impossible to read small deflections with the coil impeding the view, a non-magnetic pointer, *p*, is attached at right angles to the needle which points to zero when the instrument is ready for use, and whose angular deflections are of course the same as those of the needle. The screw seen at *s* in Fig. 32 is fixed to the glass lid of the needle box, serving to remove it when required. The metal arm A serves to connect together the two terminals, or, as it is termed, "short-circuit" the instrument. This might be required if the instrument was connected to a circuit where a current was continually flowing, the short-circuit being removed every time a reading had to be taken, and then replaced, so that the current would only pass through the coils when a reading was required. The coil of this indicator is

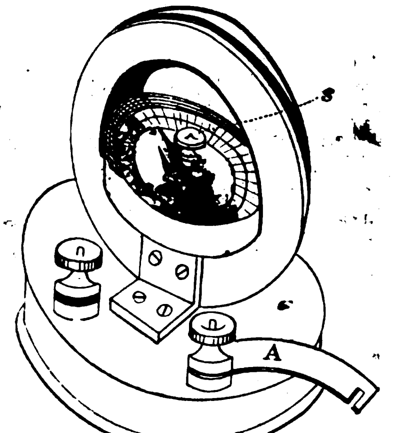

Fig 32.

about 4in. outside diameter, and is wound to a low resistance. When the indicator is set and used as above—that is, with the plane of the coil in the magnetic meridian—a deflection of 90deg. can never be reached, as this would require an *infinite* current, and, moreover, the instrument is so unsensitive to slight

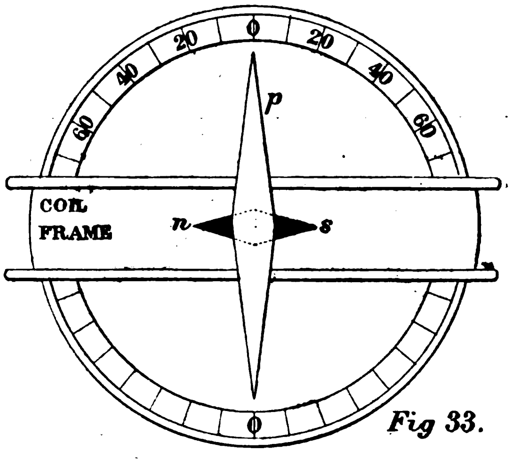

Fig 33.

changes of current when the deflection is above 75deg. that deflections are usually kept below this, if possible, when a test is taken involving reading two deflections representing two strengths of current nearly the same; in fact, the readings are most sensitive when the needle is at an angle of 45°. For testing, where slight changes in current have to be read, the deflection should therefore be first brought to this angle either by altering the resistance in the circuit or by shunting the instrument.

(*To be continued.*)

THE THERMO-MAGNETIC PROPERTIES OF IRON AND NICKEL.

In our last issue we mentioned that we hoped shortly to publish the thermo-magnetic curve of nickel, a subject which M. Menges is at present engaged in investigating. We are, however, indebted to a paper by M. Ledeboer in *La Lumière Elec-*

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trique of January 14th for a knowledge of the fact that such curves have already been published by M. Berson in the *Annales de Physique et de Chimie*, Vol. VII., p. 433, 1886, and we reproduce in Fig. 1 the curves so obtained. It will be seen that the change takes place very abruptly, and that a variation of temperature between 220deg. C. and 320deg. C. is capable of producing the maximum possible effects. The increase of temporary magnetisation with the simultaneous decrease of permanent magnetisation during the first portion of the curve is very singular.

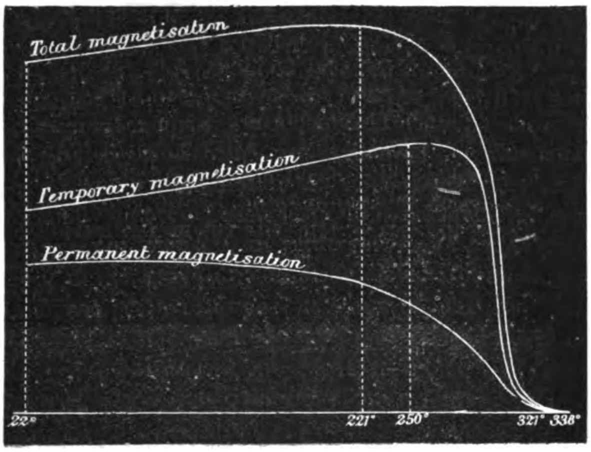


Fig. 1.—Thermo-magnetic Curves of Nickel.

The paper by M. Ledeboer above referred to contains also the results of some recent investigations of the author on the thermo-magnetic properties of iron. The iron to be experimented upon was wrapped with a coil of platinum wire, wound differentially so as to produce no magnetic field, and insulated

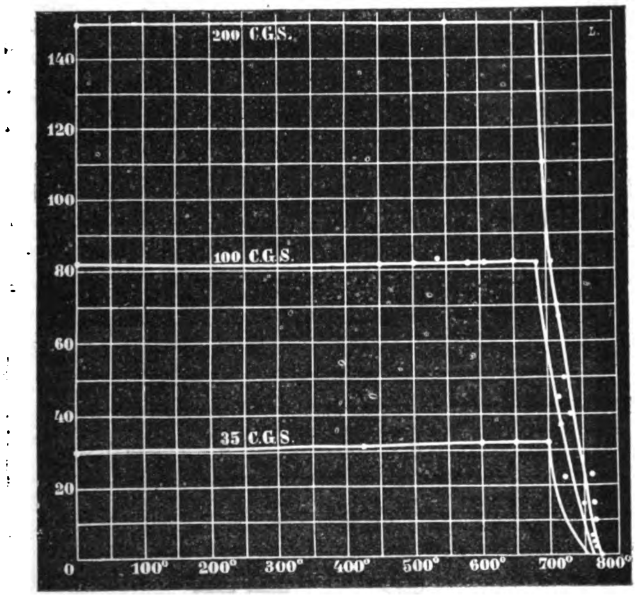


Fig. 2.—Thermo-magnetic Curves of Soft Iron.

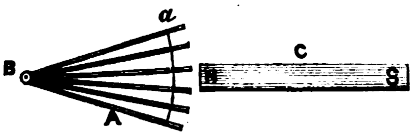
from the iron by thin leaves of mica. The bar so prepared was surrounded by a copper cylinder, and this was placed within a solenoid of much greater diameter. The iron was then raised to a high temperature by a powerful current in the platinum coils, and the heat was as far as possible prevented from reaching the solenoid by passing a stream of water between the copper cylinder and the coils. The temperature was measured by means of a thermo-electric couple contained in the cylinder. The results obtained with soft iron in fields of three different strengths are shown in Fig. 2.

COOPER'S THERMO-MAGNETIC MOTOR.

Mr. W. B. Cooper, of Philadelphia, has made a small thermo-magnetic motor, having a reciprocating action. In a letter to the New York *Electrical Review* he writes as follows :—

"A description of an experimental motor which I devised in the early part of the year 1884 may be interesting to your readers, as it is easily made and will move rapidly. It consists of a number of small radial iron wires A (Fig. 1), having a small copper wire, *a*, plaited around them to keep them in position, and secured by solder or otherwise to a vertical axis, B, their ends being trimmed to an arc of somewhat less radius than their length. A side view is shown in Fig. 2, D being a frame in which the axis moves. If the fan of wires be placed before a bar magnet, C, it will adjust itself in the horizontal plane in which it moves so that the central wires are opposite to the pole of the magnet, and if the flame of an alcohol lamp or Bunsen burner is placed under the central wires they will become heated and the fan will acquire a rapid reciprocating motion, resulting from the alternate heating and chilling of the wires above and below

Fig. 1.



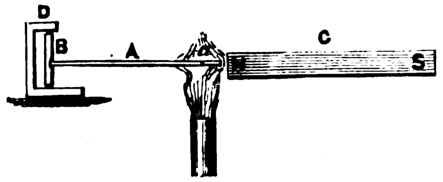


Fig. 2.

the temperature at which the critical change occurs, the ends of all the wires being at a red heat.

"To secure regular motion the flame should be completely shielded from air currents.

"A mixture of borax, glass and lime fused upon the wires will considerably reduce the oxidation."

ELECTRIC LIGHT IN STOCKHOLM.

A correspondent, writing from Copenhagen, sends us the following interesting account of the electric light in Stockholm :—

There are probably few countries where lighting by electricity seems more likely to come into use than Sweden, where one or two smaller towns are already lighted in this manner, while several others are contemplating following the example, and where a large number of factories, &c., also use the electric light. The cheap and plentiful water-power which in a great many places is available, often in the centre of the towns, or in their immediate vicinity, has no doubt something to do with this, although electric light has been adopted in many places where such favourable natural conditions do not exist.

In Stockholm there is now every prospect of soon obtaining a large central electric station, and the gasworks of the town are taking the initiative. They have recently handed in to the Corporation for their approval a plan of the contemplated electric station. The present number of electric incandescent lamps in the Swedish capital amounts to 8,300, and it has been rapidly increasing. Several matters in connection with electric light in general, its cost, &c., are touched upon in the creation from the gasworks, and it is pointed out that the town itself

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ought to build the central station. Stockholm consists of several separate districts; the electric station in question will be in the part called "Norrmalm," but it is not improbable that a second station would be wanted before long in another portion. Another reason for building an electric station is the fact that new gasworks will perhaps become necessary in a few years if the town goes on increasing. Tenders for the intended installation have been invited from five firms in England, Germany, and Austria, on all the three principal systems; preference is given to the offer from Siemens and Halske, which to a great extent coincides with a project by the engineer of the gasworks, although incurring a somewhat increased cost. The price per lamp per hour is proposed to be fixed at $4\frac{1}{2}$ öre (1d. equals $7\frac{1}{2}$ öre); the number of hours per lamp per annum is put at 700. Taking interest at 4 per cent. and an annual writing off of 7 per cent., the installation is calculated to leave a profit of 27,000kr., or about 4·3 per cent. in excess of the interest on the whole capital. The central station is intended for 8,000 sixteen-candle incandescent lamps, although it may not be considered necessary to start with boilers, engines, &c., for the whole of this at once. The total cost is put at 623,000kr. (or about £35,000); boilers, engines, pumps, &c., are calculated at 119,200kr.; wires, with the necessary works, &c., at 113,900kr.; engine house, chimney, &c., 70,500kr.; site, 180,000kr., &c. The gasworks have already received applications for 4,052 lamps (from 164 consumers), of which 1,460 were for shops, 705 for offices, 533 for cafés and restaurants, 530 for school rooms, 214 for workshops, 498 for private residences, and 112 for staircases and entrance halls.

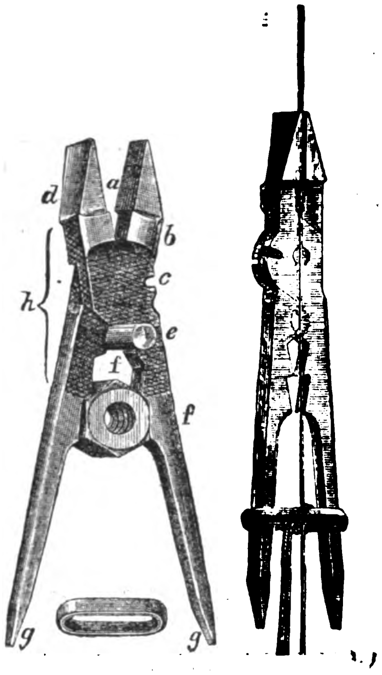
The General Post Office at Stockholm has just had electric light installed in all its different departments. There are two 30 horse-power boilers and two 20 horse-power engines with automatic expansion, and two compound dynamos. The lamps number about 350, and they can be fed from either of the dynamos. The boilers and engines have been supplied by Munktell's well-known engineering establishment at Eskilstuna, while the lamps, &c., have been supplied by the firm of Luth and Rosén, Stockholm.

The well-known firm of J. E. Ericson's Mekaniska Verkstads Aktiebolag, Stockholm, has just secured the contract for the lighting of the Swedish Houses of Parliament by electricity. The installation comprises both arc and incandescent lamps. The chambers of the two Houses are to be lighted by the former, of which there will be four in the first and six in the second Chamber. Several of the other apartments will be lighted by over one hundred incandescent lamps. A portable engine will supply the motive power. The contract is only for one year in the first instance, and the price has been fixed at 6kr. (6s. 8d.) per hour for the ten arc lamps, and the same sum for the whole of the incandescent lamps. The gas will in the meantime not be done away with. In Malmö, Sweden, three factories have quite recently had electric light laid on. At the Sconian Cement Works and at the Malmö Cloth Manufacturing Company the installations have been undertaken by the firm of Messrs. Calvert and Co., Gothenburg, while the third establishment, Mr. H. C. Olsson's copper works, has seen to it itself. Even in some Swedish villages there is some talk about electric light; for instance, those in the proximity of the Hammarfors waterfall, which would furnish the necessary power.

THE ERECTION OF OVERHEAD WIRES OF COPPER OR BRONZE.

The erection of overhead wires of copper and phosphor or silicium bronze involves a mode of operation which is somewhat different from that employed for iron wires. The following information is largely taken from a pamphlet issued by the firm of M. Lazare Weiller and Co., of Angoulême, and is issued by them solely in connection with silicium bronze wires, although it is evidently equally applicable to phosphor bronze and copper wires of small diameter.

Owing to the relative lightness and superior tenacity of bronze, compared with iron wires, it is possible to make use of less substantial supports and to employ longer spans, and the tools made use of may be of a lighter description. On the other hand, the linemen sometimes find greater difficulties in their work as their position upon the post or ladder is less well assured. It is therefore advantageous to employ as few tools as possible, and these should be easily manipulated. Such considerations have led to the design of some special



FIGS. 1 AND 2.

appliances for use with bronze wires which are due to M. J. B. Griëf, of Vienna. Fig. 1 shows his special pair of pliers.

a Ordinary pliers with smooth face.
b Pincers for small wires.
c Cutting pliers.
d Pincers for holding wires with aid of ring. (The slot in which the wire lies is seen in Fig. 2.)
e Key for screwing up insulators.
gg Screw-drivers, two sizes.
h File.

Fig. 2 shows the mode of holding a wire by means of the ring, to which is attached a cord fastened to the support.

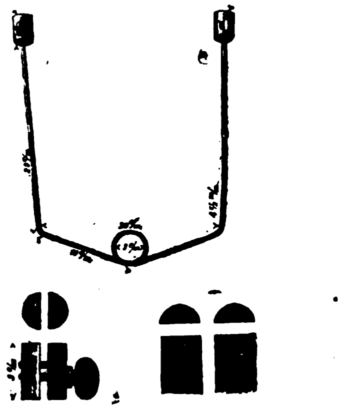


FIG. 3.

The Griëf apparatus for making joints in small wires consists of a spring fork provided at each extremity with a binding screw opened by a winged nut. This is represented in Fig. 3; it enables the ends of the two wires to be brought together without the chance of injurious bends or flexures, and permits a joint to be made with great ease.

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The mode of employing the fork is represented in Fig. 4. A piece of wood of triangular section is attached to the post by means of a cord, and to this the fork is secured, as shown in the figure. For wires of large calibre, either the Britannia joint or one made with a separate coupler is preferred, but for wires of less than 1·5mm. diameter the "Weiller" is recommended. The method of making this joint is exemplified in Figs. 5, 6, 7, 8, 9, 10, 11, which are so clear as to need no further description. The length of the ends wrapped around varies with the size of the wire, about 30 to 40 c.m. are usually made use of.

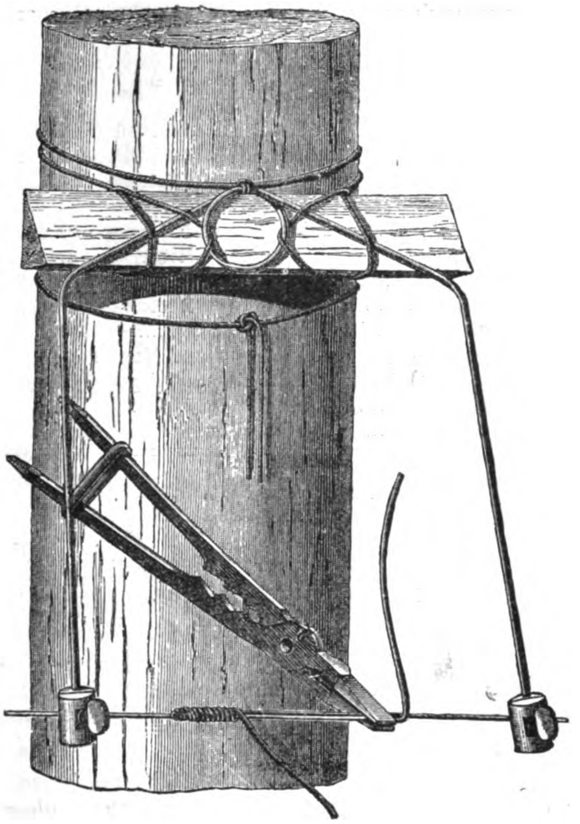
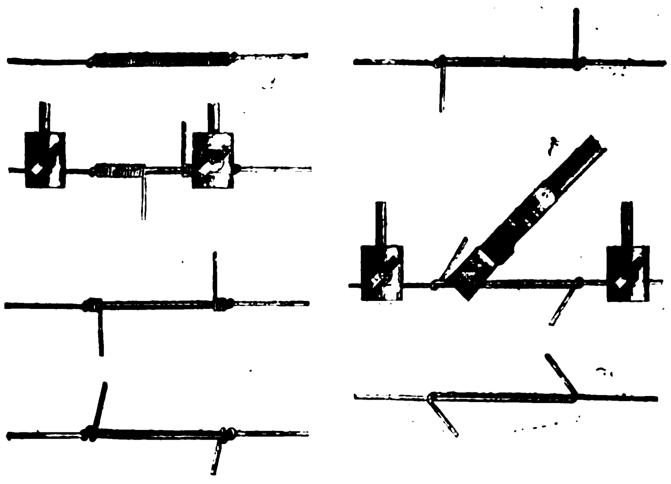


Fig. 4.



Figs. 5, 6, 7, 8, 9, 10, and 11.

The following tables show the sag allowed for some of the silicium bronze wires. Wire A_1 has a breaking strain of 44 to 46 kilogrammes per sq. mm., and a conductivity of 97 to 99 per cent. A_2, which is suitable for telephony, has a breaking strain of 80 to 86 kilogrammes per sq. mm., and a conductibility of 43 to 45 per cent. The elongation does not exceed 1 per cent.

Silicon bronze wires, type A_1, diameter 1 mm. to 1·5 mm.

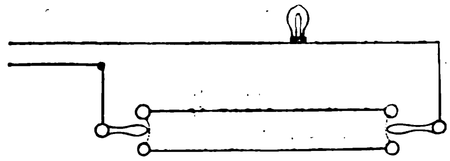
Temperature in degrees C.	Distance of posts in metres.										
	300	275	250	225	200	175	150	125	100	75	50
	Sag in centimetres.										
− 10	400	330	278	220	177	136	100	68	44	24	10
− 5	424	349	294	239	188	144	106	72	47	25	11
0	448	369	310	250	198	152	112	76	49	27	11
+ 5	472	388	327	264	209	160	118	80	52	29	12
+ 10	495	416	343	273	220	168	123	85	55	30	13
+ 15	506	422	349	282	226	171	126	87	57	32	14
+ 20	513	429	356	289	231	176	129	90	60	33	15
+ 25	521	436	362	294	235	180	133	93	62	35	15

Silicon bronze wires, type A_2, diameter 1·5 mm. to 2 mm.

Temperature in degrees C.	Distance of posts in metres.						
	150	125	100	75	60	50	40
	Sag in centimetres.						
− 10	167	115	75	41	26	19	12
− 5	175	122	79	43	28	20	13
0	185	129	84	46	30	21	14
+ 5	197	135	88	49	31	22	15
+ 10	206	143	92	52	33	23	16
+ 15	212	147	95	54	35	25	17
+ 20	221	153	99	57	37	26	18
+ 25	228	158	102	59	39	27	20

ARRANGEMENT OF INDEPENDENT SWITCHES FOR ONE LAMP.

It is occasionally required to switch a lamp, or group of lamps, in or out of circuit from either of two points. This has been done hitherto by the use of two very complicated magnetic switches; but the following exceedingly simple and neat solution of the problem was recently described in *L'Electricien*:—*a* and *b* are two two-way switches. It will be seen on inspection that if either be switched across to the other contact it puts the lamp out of circuit. Then, if again either is switched over it puts the lamp on once more.



MEETINGS OF SCIENTIFIC SOCIETIES.

(Week ending Thursday, 26th January.)

TO-NIGHT (FRIDAY), January 20th.

Royal Institution.

9 p.m. Lecture, "Diffraction of Sound." By the Right Hon. Lord Rayleigh.

SATURDAY, January 21st.

Royal Institution.

3 p.m. Lecture, "Experimental Optics." By Lord Rayleigh.

MONDAY, January 23rd.

Inventors' Institute.

8 p.m. Ordinary Meeting.

TUESDAY, January 24th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Paper, "The Jubilee Bridge over the River Hooghly." By Sir Bradford Leslie.

Royal Institution.

3 p.m. Lecture, "Before and After Darwin." By Mr. Geo. J. Romanes, M.A., &c.

WEDNESDAY, January 25th.

Society of Arts.

8 p.m. Ordinary Meeting. "Theatres and Fireproof Construction." By Mr. Walter Emden.

THURSDAY, January 26th.

Society of Telegraph-Engineers.

8 p.m. Meeting. Discussion on the following Paper, "On Safety Fuses for Electric Light Circuits, and on the Behaviour of the Various Metals usually employed in their Construction." By Mr. Arthur C. Cockburn, F.C.S., Associate.

Royal Institution.

3 p.m. Lecture, "My Visits to America." By Mr. H. Herkomer.

Royal Society.

4.30 p.m. Ordinary Meeting.

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(Concluded.)

Post Office Telegraphs.

Perhaps the most striking fact connected with the Postal Telegraph System of this country during the past year is the quite inconsiderable amount of additional wire erected for the accommodation of the enormous and constantly-increasing traffic. With the exception of the new copper line from London to Ireland, and the necessary extensions to embrace minor outlying districts in the provinces, the mileage of working lines remains pretty much what it was in 1886. How, then, has the additional traffic with which the existing wires is now encumbered been dealt with? Mainly, and we might almost say exclusively, by improvements in the electrical appliances, the perfection of which is every year augmenting the capacity of the wires without adding to their number. The working staff has to be increased, and the apparatus multiplied; but the costly operations of erecting fresh wires is avoided, and postponed almost indefinitely by the care and thought bestowed upon the instruments, and by experimental investigations to determine more exactly the idiosyncracies of each individual line, and the possibilities of manipulating the signalling current so as to get the highest possible speed out of it. On the new Irish wire just mentioned, the duplex method has been adopted, and a speed each way of 230 words a minute, or a total of 460, has been already attained with the automatic system. This speed, however, is largely attributable to the employment of copper for the conductor, a circumstance which has led to some highly important revelations in practical telegraphy, the self-induction of the copper wire having been found to be virtually *nil*. This new fact in telegraphy and its practical application we owe to Mr. W. H. PREECE. Much regret is expressed by the administration that this discovery is for the present rendered almost valueless by the abnormal rise in the price of copper, the use of which for telegraph lines would otherwise have been greatly extended. Mr. PREECE concluded one of his papers at the British Association meeting last year with the remark that "the virtual absence of electro-magnetic inertia in copper wire is leading to its extensive adoption for telegraphy, and no other wire should ever be used for telephony." But this was said when copper

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was at half its present price. The effect of its enhanced cost, however, will be probably to spur the electrical department to fresh expedients for coping with the increasing traffic on iron wires. Already the introduction of high-speed repeaters and the use of shunted condensers have raised the average rate of transmission almost to the limits of the capacity of the staff, 450 words a minute being reached with ease on circuits of 200 miles in length, and on some circuits as many as 600 words. Beyond that distance the rate would fall off proportionately but for the introduction of the fast-speed repeater at intermediate distances, which enables the communication between such places as London and Dublin, London and Glasgow, and even Aberdeen, to be maintained at the highest speed. This high-speed repeater is said to owe its efficiency to the perfection of the Post Office standard relay—a relay which has practically no time-constant, which responds to exceedingly delicate currents, and which makes perfect electrical contacts—and to the use of condensers. Repeaters have been introduced on forked news wires, so that offices on separate branches of a circuit worked as one can communicate with each other and with the terminal office without interrupting each other's signals. By means of a repeater at Leeds the Delany multiplex system has been found practicable to Glasgow, and by a similar device Scarborough and its sub-offices are working multiplex to Leeds. Some valuable results have been obtained by the employment of condensers on land lines with the object of making the signals clearer; and it is intended to do away with the intermediate sounder on quadruplex circuits by making use of the extra current of the cores. A new key has been designed for multiplex working, and several improvements made in the testing galvanometers, as well as in the relays to increase their sensibility. Some experiments are in progress for determining the time-constant of electromagnets in relays, which it is believed will lead to very useful results for practical telegraphy. Turning to the less important instruments of the service, the single needle has been fitted with tin sounders, which have the effect of converting the needle into an acoustic receiver. On its underground system the Post Office have lately adopted a new core for its cables, the copper of which is much heavier in proportion to the gutta percha insulator than heretofore. They have also devised an improved method of testing "seconds," or restored gutta percha covered wire with a view to increase its durability by eliminating incipient faults before laying. Of the Post Office Telephone System we need say very little; wherever it is working it is confessedly excellent in every particular, except perhaps in extent, for in reality the department seems to have ceased to make even a show of competing with the companies, who consequently have the field almost all to themselves. Nevertheless, the public are gainers by the Post Office's indefatigable efforts to improve the telephone and its accessories as an electrical speaking instrument. The distance at which induction can be felt on telephone wires has been determined with tolerable precision; and the limits of audibility being ascertained, the current necessary to produce an audible signal on the Bell telephone has been calculated. It has also been found that the possibilities of long distance underground telephony, when suitable copper wire is employed, are far greater than at first was imagined. Full particulars of these investigations having been communicated to the Royal Society and British Association last year, and published in our columns at the time, we need not repeat them now. It is sufficient to note that the public reap the advantage in the creation of a high standard of efficiency by the Post Office Telephone Service, at which standard the companies must continually aim in order to retain their hold on public favour. The number of telephone instruments actually in use under Post Office control at the end of the year was 4,481, being an increase of 366 on the corresponding period 1886. Except in respect to the telephone, no exact information is available down to the close of 1887. Nine months ago, however—that is to say, at the end of the financial year, 31st March, 1887—the total length of telegraph lines, overhead, underground and submarine, worked by the Post Office in the public service was 27,935¼ miles, representing 156,220 miles of wire. These figures do not include wires which are rented from the department for private use, and which represent a mileage of 17,318¾. At the date mentioned above the Post Office possessed 1,540½ miles of submarine cables, the wiring of which was equivalent to 5,050¼ miles. In regard to apparatus, the total number of instruments actually in use was 11,530. Of these 3,040 were sounders, which are rapidly displacing the Morse printer. There were 398 fast-speed automatic instruments in operation, exclusive of multiplex apparatus; and 105 repeaters. The pneumatic system, connecting some of the principal offices in London and other large towns at the date referred to, measured 46¾ miles. We may mention in concluding this review of the work of the Post Office Telegraphs that the central hall of the chief office in London and various other rooms in the building are now fitted with the electric light.

Cables.

POST OFFICE.—The cable operations of the Post Office during the past year have been confined to the maintenance of existing cables, which, for the most part, have suffered no serious damage. Of the Companies' cables there are few operations of any kind to record; but the following particulars may be of interest, relating to

THE EASTERN TELEGRAPH COMPANY.—The most important cable operation of this company during the past year was the laying of a duplicate cable from Porthcurnow to Malta; and also a direct cable from Malta to Zante. The lengths are given below:—

		Nautical Miles.
Porthcurnow	to Lisbon, No. 2	891
Lisbon	„ Gibraltar, No. 2	337
Gibraltar	„ Malta, No. 2	1,126
Malta	„ Zante	374
		2,728

In February the ss. "Electra" connected Gibraltar with Tangier, 33 nautical miles. On the 18th April, before daylight, the ss. "Volta" struck on the north coast of Mykonos Island, in the Levant, and became a total wreck. The captain, two assistant electricians, and eight of the crew were lost. During the month of November the ss. "Mirror" laid a duplicate line between Zante and Patras, 58 nautical miles. A new ship, to be named the "Amber," is being built at Messrs. Napier's, Glasgow, to replace the "Volta," and was successfully launched yesterday, as will be seen by the account which we print in another column.

The Telephone.—*(Concluded.)*

THE EQUITABLE TELEPHONE ASSOCIATION.—The following details of the work of this company are given as supplementary to our last week's article on the telephone in 1887:—

The Equitable Telephone Association has adopted the principle of selling their telephones outright, and charges a small annual fee for maintenance when required. The success of this system is evidenced by the fact that though the Associa-

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tion has only just completed the first year of its existence a large number of the "Swinton" telephones are now in use in various parts of the country, and are employed by such eminent firms as Messrs. Sir W. G. Armstrong, Mitchell and Co., of Elswick; the Bute Docks Company; Messrs. Tancred, Arrol and Co.; the Co-operative Wholesale Company, and many others. Since the "Swinton" telephone was first described in *The Electrician* (June 10, 1887) several modifications have been introduced in the form of the instrument. One of these—a cheap and simple form of telephone, suitable for use as a substitute for speaking tubes and mechanical telephones over short distances—was placed on the market in October last, and has met with a great measure of success. It will be remembered that the original Swinton instruments worked with direct-battery currents without induction coils. This arrangement, though it answers very well for short circuits, has several disadvantages on lines of considerable resistance and for exchange systems, and the Association has therefore recently introduced a modified instrument for long distances in which induction coils are employed. Messrs. Sir W. G. Armstrong, Mitchell and Co., of Elswick, have had a pair of these new instruments working on a three-mile line of iron wire for some time, and report that they are giving satisfaction.

LAUNCH OF A CABLE STEAMER.

Yesterday (Thursday) afternoon Messrs. R. Napier and Sons launched from their shipyard at Govan the telegraph cable steamer "Amber," for the Eastern Telegraph Company.

The vessel has been specially designed by Mr. Joseph Birnie, London, for laying and repairing the company's submarine cables, and while externally the steamer has the appearance of a Trinity yacht, internally the arrangements are of the most complete character for the difficult and delicate task she is intended for.

Besides the usual appliances of a first-class modern steamer, the vessel is fitted with large circular tanks for holding the telegraph cables, and has been sub-divided into numerous watertight compartments for trimming and ballasting purposes. Her dimensions are—length 210ft., breadth 31ft., depth 24ft., classed 100 A1 at Lloyd's under special survey. Very complete and comfortable accommodation has been provided for the large staff of officers, electricians, and crew, with the necessary chart house and testing room, which will be fitted with the best instruments for the task the vessel will be engaged upon. The bow sheaves give the vessel a peculiar appearance, but they have been wrought in by the builders in an ingenious way to form part of a clipper bow, which adds to the symmetry of the design.

The machinery will consist of triple expansion engines, which have been constructed at Messrs. R. Napier and Sons' Lancefield Works, under the supervision of Mr. Beldam, London.

In the absence of the Marchioness of Tweeddale, who was to have christened the vessel, the ceremony was performed by Miss Agnes M. Hamilton, who named her the "Amber" as she left the stocks.

After the launch Mr. KIRK proposed "Success to the newly-launched vessel," mentioning that this was the fifth vessel they had launched for the Eastern Telegraph Company. Mr. JOSEPH BIRNIE briefly replied on behalf of the Company. Mr. R. M. RENWICK proposed "The Health of the Builders," Messrs. Napier and Sons, whose ability to build cable ships had been so often proved that it was not likely the Eastern Company would find better builders anywhere.—Mr. JAMES HAMILTON replied for the builders, and hoped that their connection with the Eastern Telegraph Company might long continue.—After a vote of thanks to Miss Hamilton the proceedings closed.

CENTRAL STATION INDICATING INSTRUMENTS OF THE EDISON COMPANY.

The following account of the indicating instruments employed by the Edison Company of America is taken from our New York contemporary, the *Electrical World*:—

For incandescent lighting it is necessary to maintain a constant pressure on the circuit. In any plant the pressure is fixed by the lamps used, and it is necessary to keep the pressure invariably at this point, and no other pressure concerns the attendant in the least. The engineer should have a pressure indicator which enables him to see readily *from a distance* whether or not the pressure is right. A zero instrument enables him to do this, as when the pressure is right the pointer is at zero, in the middle of the scale, and a change of one volt may deflect the pointer half an inch or an inch from zero if desirable. Such small changes in voltage may be easily seen from a distance and the pressure be kept right.

The pressure indicators used by the Edison Company are all zero instruments; they can be adjusted for the pressure used in any plant, and the divisions on the scale in front of which the pointer swings are ⅞in. apart; and to deflect the pointer over one of these divisions requires a change of two volts in the pressure on the line.

The Edison Company have for some time been using a number of instruments for this purpose, built at the Edison lamp works at Harrison, N.J. These instruments embody a variety of principles in their operation, but it will be noted from the descriptions that follow that nearly all are designed on the zero method of

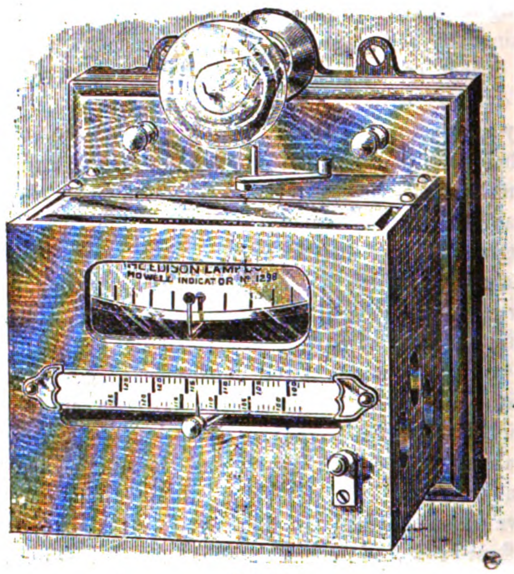

Fig. 1.

indication. By adopting this principle the use of springs, electromagnets, or permanent magnets as acting forces is avoided. The permanent magnet employed in the instruments is in the shape of a needle, which indicates the true reading only when in a neutral position—that is, when it is not acted upon, or is in equilibrium. These instruments include for the most part apparatus for measuring the potential or pressure carried on the circuit, as this is evidently the principal point to be considered in the operation of incandescent lights. We propose to describe these various instuments, and shall begin with the standard pressure indicator.

This instrument is shown in perspective in the engraving, Fig. 1, and by its means all variations in pressure are immediately indicated.

The principle upon which the action of the indicator depends is the great variation in the resistance of a carbon filament due to change of temperature. The circuit to be measured is made to act upon the carbon filament, sending a current through it, and the amount of current which flows through the filament is determined by the pressure on the circuit and varies with this pressure. The temperature of the filament varies with the current, and so also does its resistance. Hence, by measuring the resistance of the filament at any time, we measure indirectly the pressure or potential acting upon it. The indicator is simply a Wheatstone bridge arrangement, by which the resistance of the filament is measured when a current is flowing through it. Although in reality the resistance of the carbon filament is measured, the marks upon the scale give the volts or pressure necessary to bring the carbon to that resistance, and hence such a scale gives a direct measure of the pressure of the circuit.

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The diagram, Fig. 2, shows the essential details of the indicator. Here L represents a high resistance lamp, giving the necessary high carbon resistance, and D is a coil of wire heavy enough to carry the lamp current without heating too much. These two resistances form one arm of the bridge. The other arm is made up of three wire resistances, A, C, and B, and the galvanometer is connected between the point F and the frame upon which the sliding contact S slides. This enables the galvanometer contact to be made at any point of the resistance C. If A plus that part of C on the left hand side of the galvanometer contact be represented by A′; and B, plus the part of C on the right hand side of the galvanometer contact be represented by B′, then, when the bridge is balanced and no current flows through G, we have A′ D = B′ L. G is a simple galvanometer which shows the direction and relative amount of the current flowing through it; when the hand is on zero no current is flowing in G.

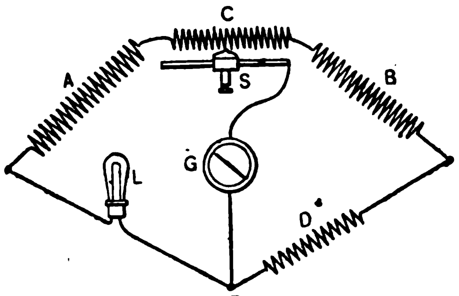

Fig. 2.

Now, if the sliding contact be in the centre of resistance C and a suitable lamp be in L, on sending a current through the indicator and gradually increasing it the resistance of the filament becomes less and less, until, when the desired pressure is acting upon the indicator, we have A′ D = B′ L. No current flows in G, and the pointer remains on zero with the circuit either made or broken. This position of the sliding contact is marked to indicate what this pressure is, and if at any time the contact be placed at this point and the pressure made such that there is no current in G, it is evident that the indicator shows the same pressure as that employed when it was adjusted at that point. The indicator being thus balanced, if the pressure be increased the pointer will move to one side of zero; if it be decreased it will move to the other side.

If now the sliding contact be moved to some other point it will alter the values A′ and B′, and the pressure will have to be changed until the resistance of L is changed enough to make A′ D = B′ L again. This position of S, corresponding with the new pressure, can be marked, and in this way can be found the pressures that will balance the bridge with the contact S, in any position on the coil C. Thus the scale can be marked for a range of volts. The pressure of the circuit can then be set at any point that is on the scale, and changing the pressure on the line until the bridge is balanced and the pointer remains at zero, with the galvanometer circuit either open or closed.

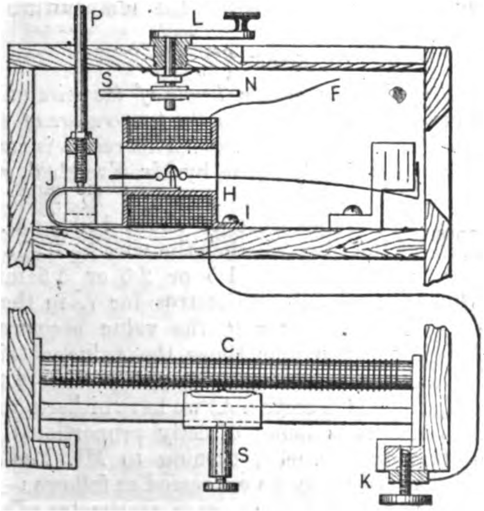

Fig. 3.

The upper half of Fig. 3 shows the galvanometer in section, and below is shown the resistance C and the sliding contact S, which makes the galvanometer contact at any point of the resistance. The magnetic needle in the galvanometer consists of two pieces of steel wire, one on each side of the jewel centre; the steel point upon which the needle swings is fixed to a brass support, H. The spring J is normally in the position shown in the illustration, being held down by the pin P. If the latter be raised by unscrewing it, the spring J will rise and lift the needle off its steel supporting point, and hold it against the frame of the galvanometer. This is done whenever the indicator is carried about or handled; otherwise the steel point might become dull or be broken. The directing magnet, N S, overcomes the earth's magnetism and makes a magnetic field for the galvanometer, which enables the pointer to be brought to zero, whatever the position of the indicator; the directing magnet may be moved one way or the other by the lever L. The galvanometer circuit runs from F (Fig. 3), through the galvanometer, through the switch to the metal frame on which the sliding contact travels, and through the sliding contact to the point of contact on resistance C. The switch is a simple screw connecting the brass block K, to which the galvanometer wire is fastened, to the metal frame carrying the sliding contact. When the screw is withdrawn one or two turns, so that it no longer touches the frame of the slider, the galvanometer circuit is broken. The upper part of the box, which contains the galvanometer, is separated from the lower part, which contains the resistances, by a wooden partition, to which the galvanometer and scale are fastened.

Fig. 4 shows the connections of the indicator as they exist in the instrument, the coils, however, being shown separately. These connections, four in number, are shown in the order in which they exist in the indicator.

The resistances A, B and D are wound upon one wooden spool, which is placed on the lower part of the box under the partition. This space is ventilated through the sides and bottom, front and back of the box; the spool is also made so that the wire upon it is well ventilated. The resistance C and the frame carrying it and the

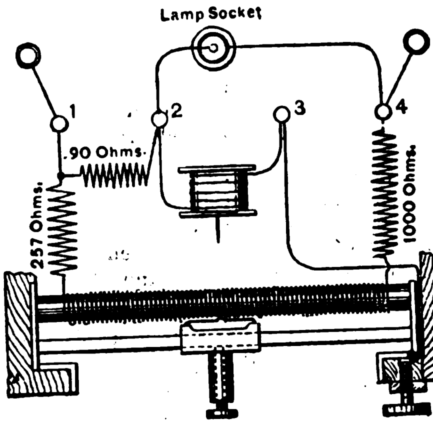

Fig. 4.

sliding contact are placed in the lower part of the box. The handle by which the sliding contact is moved projects out through a slot in the front of the box so that it can be easily moved.

The lamp forming the high-carbon resistance is screwed into a socket on the base of the indicator just above the box holding the galvanometer and resistances. Half of the top of this box is of glass, so that the light from the lamp shines through the glass upon the back of the paper scale, in front of which swings the end of the hand or pointer of the galvanometer. This paper scale being translucent allows enough light to pass through it to enable one to see the pointer and scale readily.

The indicator is so constructed that its readings are correct for all temperatures. This is effected by making the coils A and D of German silver wire, and the coil B partly of German silver and partly of copper. By suitably proportioning these parts the indicator remains balanced at any temperature.

A lamp that has been tested and sent out with an indicator is not likely to change, and experience shows that they remain constant for a very long time. Nevertheless, to correct any possible change in a lamp an extra lamp is sent with each indicator. Of these two lamps only one can be used at any one time, and points are marked on the scale for each lamp.

It will also be noticed that, as shown in Fig. 1, two scales are marked on the indicator. These are respectively drawn in red and black ink, and the lamps sent with the indicator are marked with red and black to correspond. The object of this is to afford a means of checking the accuracy of the readings by employing one lamp solely for the purpose of comparison, which is used but seldom, and whose resistance, therefore, does not vary. The other lamp is employed continuously, and any variation in its resistance is shown when compared with the standard lamp.

In isolated plants the indicator is connected either to a part of the circuit where lamps are connected, and if possible to a circuit

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where lamps are burning most of the time, or to the centre of distribution, if there is only one such centre. In the latter case it is necessary to set the indicator for a pressure higher than the lamp pressure by the loss from the centre of distribution to the lamps. Thus, if in 103-volt plant the loss from the centre of distribution to the lamps is 3 per cent., the indicator is set for 106 instead of 103 volts, since the pressure indicated is that at the indicator itself.

In central stations using comparative indicators three pressure indicators are employed. Two of these are connected to the pressure wires from the end of the standard feeder, and one is used as a standardising indicator to adjust the first two at any time. The two regular pressure indicators, being connected to pressure wires, cannot be standardised properly before sending out, as the pressure wires are in circuit with them, and the pressure at the indicator is the pressure at the feeder end, less the drop on the pressure wires ; and as this drop is an unknown quantity, it cannot be allowed for until the indicators are connected in the drop to be measured. No scale is therefore marked on these two indicators. The third or standardising indicator used in connection with central stations has a scale marked on it, covering a range of about 15 volts. In using this indicator it is put in circuit in place of either one of the two regular pressure indicators, to tell whether these have changed in any way. This is accomplished by means of the switch shown in Fig. 5. P P are the two pressure indicators, and S is the standardising indicator. When the arms of the switch are in the position shown in the diagram the two pressure indicators are in circuit, but the standardising indicator is not in circuit. Throwing the arms of the switch on either side cuts one of the pressure indicators out of circuit, and throws the standardising indicator in circuit in its place. When used in this way the reading on the standardising indicator should be less than the pressure it is desired to maintain at the feeder ends by the drop in the pressure wires. If these pressure wires are copper wires (about No. 12), this drop is negligible, and the standardising indicator should balance at the feeder end pressure. If, however, the pressure wires are iron, the drop is often four or five volts, and must be allowed for. In this case the standardising indicator should be balanced at four or five volts lower than the feeder pressure. This drop is determined by the voltmeter.

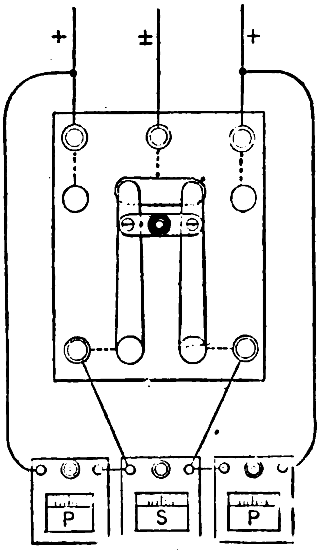


Fig. 5.

THE SWINTON SWITCH-BOARD FOR PRIVATE TELEPHONES.

We illustrate herewith a simple and effective arrangement devised by Mr. Swinton, of the Equitable Telephone Association, in order to dispense with the necessity for a central exchange in cases where the telephone is used as a substitute for speaking tubes in hotels, factories, warehouses, or other buildings. Where speaking tubes are employed in order to speak from any one station to any other, it is obvious that for n stations $\frac{n(n-1)}{2}$ separate tubes are necessary ; but in this system the same end is attained with only $n+2$ wires. The connections are shown in the adjoining figure. A small switch-board is attached to each instrument, and a flexible cord is provided with a plug which is inserted in the plug-hole corresponding with the station required. It will be seen that the left-hand plug hole of each switch box is marked with the letter that denotes the individual station to which this switch-box belongs. Z and C are the wires connecting the various switch-boxes to the zinc and carbon terminals of the battery, and 1, 2, 3, 4 are the four line wires that are necessary to connect the various switch-boxes together. The terminals of the boxes are numbered, and and all bearing the same number are connected to the same wire. When the telephones are not in use the receivers are all hung up on their respective switch-hooks, and the plugs are inserted in the left-hand plug holes of the several switch-boxes. Thus the plug belonging to A is inserted in the hole marked A, that belonging to B in hole B, and so on, as shown in the illustration. Supposing A wishes to communicate with C, he has only to remove his receiver from its hook, remove his plug from the hole marked A of his switch-box, and insert it in the hole marked C, to cause the call bell at C to ring, the ringing of the bell notified to A by the noise in his telephone receiver, due to the contact breaker of the bell at C.

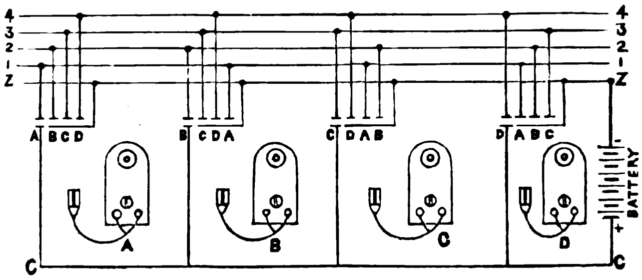
On C removing his receiver from its hook the noise ceases, and A knows that he can talk to C and *vice versâ*. When the conversation is completed A replaces his plug in the A hole of his switch-box, so that other stations may be able to call him up if required.

In a similar manner any one of A, B, C, D can call up and carry on a consersation with any other, and A and B can talk together while C and D are doing the same, or any other combination can be effected.

If, however, B tries to call up A or C while the latter are conversing with one another, their bells being now out of circuit, the absence of the rattling noise in his receiver on his attempting to call attention intimates to B that the line is engaged. This prevents interruptions of conversation and any possibility of confusion.

The above examples show the principles of the system when applied to four stations, but of course, the switch-boxes can be made with any number of plug holes for a system comprising any number of stations ; and when it is convenient that only some of the stations should have the power of calling up all the others, only these particular stations need have switch-boxes containing the full number of plug holes, and be connected with the full complement of wires.

We have recently inspected an installation of this character in the city, and found the arrangements to answer every purpose for which they are designed. In another building a set of twenty-seven telephones are being fitted on this system. We fully anticipate that a considerable demand will arise for Mr. Swinton's simple and ingenious device.



The Swinton Switchboard.

PORTABLE VOLTMETERS FOR MEASURING ALTERNATING POTENTIAL DIFFERENCES.*

BY W. E. AYRTON AND JOHN PERRY.

(*Continued from page 244*)

B.—Waste of Power in the Voltmeter.

From the equations previously given it follows that the waste of power in watts spent in keeping a long fine wire l_0 centimetres in length $\theta°$ C. above the temperature of the surrounding space equals

$$0{\cdot}0008848\,\pi\,l_0\,\theta,$$

a value which depends only on the length of the wire and on the temperature to which it is raised above the temperature of the case, but not at all on the diameter of the wire. This result is confirmed by the experiments recently made by Mr. Evershed, who has found that about 36 watts are required to keep a wire 3,600mms. long at a temperature of about 180deg. C. above the temperature of the case, whether the wire be 0·038mm. or 0·0635mm. or 0·0889mm. (*i.e.*, 1·5 or 2·5 or 3·5 mills.) in diameter. Substituting 360 centimetres for l_0 in the above expression, and 180deg. C. for θ, the value becomes 180·2 watts. This is more than four times the value obtained by Mr. Evershed, and the reason may be partly due to the fact that (as already noticed in section A) we have hitherto regarded the rate of loss of heat as being directly proportional to the difference of temperature. On turning to Mr. McFarlane's paper we find his result may be expressed as follows :—

Loss of heat per second per square centimetre of a bright copper ball 2 centimetres in radius for a difference of temperature $\theta°$ C.

$$= \text{Loss for 1deg.C.} \times \theta \left(\frac{0{\cdot}000168}{0{\cdot}000170} + \frac{1{\cdot}98}{{\cdot}000170} \times 10^{-6}\,\theta - \frac{1{\cdot}7}{{\cdot}000170} \times 10^{-8}\,\theta^2 \right).$$

Instead, therefore, of writing as above the expression for the rate of loss of heat in watts required to maintain a long wire l_0 centimetres in length at a temperature $\theta°$ C. above that of the surrounding space, it will probably be more correct to write it as something like

$$0{\cdot}0008848\,\pi\,l_0\,\theta\left(\frac{0{\cdot}000168}{0{\cdot}000170}+\frac{1{\cdot}98}{{\cdot}000170}\times 10^{-6}\,\theta-\frac{1{\cdot}7}{{\cdot}000170}\times 10^{-8}\,\theta^2\right).$$

If now we substitute 360 centimetres for l_0 in this expression, it becomes

$$\theta\,(0{\cdot}9883+0{\cdot}01165\,\theta-10^{-4}\,\theta^2)\text{ watts.}$$

Of course we cannot expect this expression to give absolutely correct results for any values of θ, seeing that Mr. McFarlane's experiments did not extend beyond θ equal 60° C. The expression is interesting, however, as showing that, in consequence of the negative term, ϵ must be taken as having a smaller value when θ is high than when θ is low. For θ equal to 180° C, which was about the excess temperature of the wire in Mr. Evershed's experiments, the formula as it stands cannot be applied, as it leads to a negative answer; but for θ equal to 164·5° C., it gives, as it happens, almost exactly 36 watts, the power Mr. Evershed found was expended in any one of the three wires he tried.

Mr. Evershed informs us that he estimates the temperature to which the wire is raised by measuring its expansion; we, on the other hand, have found it more convenient, with our form of voltmeter, to estimate the rise of temperature of the wire by measuring its increase of resistance. Employing this latter method we find that, roughly, 3·5 watts per foot are necessary to maintain a very fine platinum-silver wire at a temperature of 200deg. C. above that of the case. This result is rather higher than that obtained by Mr. Evershed, and corresponds with a value of ϵ equal to about $\frac{0{\cdot}0002}{d}$.

In the absence of the results of experiments made for many values of θ it is impossible to say what is the exact function of θ that ought to be employed in the expression for the watts, and consequently we are at present engaged on experiments for determining this function; from what we have given, however, there is reason to think that the expression for the watts required to be spent in maintaining a long fine wire at any temperature θ above that of the surrounding space is a function of the length of the wire and the excess temperature only, and is nearly, if not entirely, independent of the diameter of the wire.

C.—The Range in Volts.

If θ_1 be the highest temperature of the wire allowable; if V_1 volts be the range of the instrument without using external resistance coils, then, from (4),

$$V_1=2\,l_0\sqrt{\frac{\epsilon\,\rho\,\theta_1}{d}}\quad\ldots\ldots\quad(10)$$

so that this range is proportional to l_0—that is, to the length of wire through which the current passes in going from one terminal to another of the instrument. Hence, if there are 10 wires, each of length λ_0, we can make $l_0=10\,\lambda_0$ by placing the wires in series, or $l_0=\lambda_0$ by placing them in parallel by means of a commutator.

Since, for small wires, ϵ is inversely as d, the range in volts increases directly as the length of the stretched wire and inversely as its diameter. As, however, increasing the length increases the waste of power in the instrument, it is rather by diminishing the diameter of the wire that the range in volts ought to be increased.

If a small range in volts be desired, it is better, in order to avoid waste of power, to use one thick wire than several thin wires in parallel; and this rule ought to be followed as long as the thick wire is sufficiently quick in its action.

In order, however, to obtain a great range, it may in many cases be desirable to employ a many-wire voltmeter with a commutator, in spite of the fact that this arrangement does not give us the instrument that is most economical in the power wasted when a few volts are being measured.

D.—The Greatest Angular Deflection of the Pointer.

With any given spring, it is obvious that we ought to tighten the wire and adjust the initial tension in the spring until the initial pull in the wire is q—the greatest pull to which the wire ought to be subjected—and also until we find that at the highest temperature the spring is just able to keep the wire taut. In our instruments, where the wires lie nearly all parallel to one another, we have these two adjustments, and also in those with the bicycle-wheel arrangement of wires, in which the outer ends of the wires may be attached to adjustable flexible strips. For the sake of easy calculation we may take the final pull in the spring as 0. Let L be the length of the spring, ϕ_1 the deflection of the pointer when θ_1 (the highest temperature of the wire) is reached, P_0 the initial pull in the spring. By the triangle of forces

$$P_0=\frac{4\,y_0\,q}{l_0}\quad\ldots\ldots\quad(11)$$

(If there are n wires caught by the end of the spring, say n complete diametral wires in the bicycle-wheel form, then then instead of q we must use $n\,q$.)

The law of the spring is such that

$$y_1-y_0=r\,P_0\,L\frac{a}{t^3}\quad\ldots\ldots\quad(12)^*$$

where r is the radius of the coils of the spring, L its axial length, a a constant depending on the material of the spring, t the thickness of the strip of which the spring is made; and another law of the spring is

$$\phi_1=P_0\,L\frac{b}{t^3}\quad\ldots\ldots\quad(13)$$

where b is a constant like a. In fact, $\frac{b}{a}$ is the constant s used in (6).

Substituting for P_0 from (11) in (12),

$$y_1-y_0=r\,L\,\frac{a}{t^3}\,\frac{4\,q}{l_0}\,y_0=S\,\frac{r}{t^3}\,y_0,\text{ say}\quad\ldots\quad(14)$$

equation (2) is $y_1{}^2-y_0{}^2=\frac{1}{2}\,l_0{}^2\,a\,\theta_1=R$, say.

Dividing by (14), we have

$$y_1+y_0=\frac{R\,t^3}{S\,r\,y_0};$$

so that

$$y_1=\frac{R\,t^3}{S\,r\,y_0}-y_0.$$

Substituting in (14), we find

$$\frac{R\,t^3}{S\,r\,y_0}-2\,y_0=S\,\frac{r}{t^3}\,y_0,$$

or

$$y_0=\sqrt{\frac{R}{S\,\frac{r}{t^3}\left(S\,\frac{r}{t^3}+2\right)}}\quad\ldots\ldots\quad(14)$$

Substituting for P_0 from (11) in (13),

$$\phi_1=\frac{L\,b}{t^3}\,\frac{4\,q}{l_0}\,y_0\quad\ldots\ldots\quad(15)$$

and using y_0, just found, in which $R=\frac{1}{2}\,l_0{}^2\,a\,\theta_1$, and $S=\frac{4\,L\,a\,q}{l_0}$, we find eventually that

$$\phi_1=\sqrt{a\,\theta_1\,\frac{b^2}{a}\,\frac{L\,q\,l_0{}^2}{2\,L\,a\,q\,r^2+r\,t^3\,l_0}}\quad\ldots\ldots\quad(16)$$

where neither of the two terms in the denominator is negligible. The observation in brackets given after (11) tells us that we may use $n\,q$ instead of q in the formula if there are n lengths of wire or n complete diametral wires in the bicycle-wheel form of instrument. An examination of (16) will show how the range ϕ_1 may be made large.

The following are the deductions that may be drawn from (16):—

1st. If f be the working stress suitable for the material of the wire, $q=f\,\frac{\pi}{4}\,d^2$, or $n\,q=n\,f\,\frac{\pi}{4}\,d^2$;

so that, if we desire a large maximum deflection without reference to the range of volts, we ought to use wires as thick as

* "A New Form of Spring for Electric and other Measuring Instruments," Proc. Roy. Soc., No. 230, 1884, p. 311.

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possible, or else use many spokes in the bicycle-wheel form. The limit to the thickness that may be given to the wires arises from the fact that the heat equilibrium will only be established slowly with thick wires, so that the dead-beat character of the instrument suffers if the wires be too thick.

2nd. The greater l_0 is, the greater is the maximum deflection. Hence the greater the diameter of the bicycle-wheel and the more numerous the spokes, the greater the maximum deflection. Also, the greater the diameter of the bicycle wheel and the greater the number of spokes, still more noticeable is the range in volts.

3rd. Diminishing the thickness (t) of the strip of metal of which the spring is made has a *very great* effect in increasing the maximum deflection.

4th. Increasing the length (L) of the spring increases the maximum deflection just in the same way as increasing q or $n q$.

5th. Diminishing r, the radius of the coils of the spring, produces a great increase in the maximum deflection.

(*To be continued.*)

CARBON AS A POSITIVE ELEMENT.*

BY WILLARD E. CASE.

[We are indebted to the Secretary of the American Institute of Electrical Engineers for a copy of an interesting paper read before the Institute on January the 10th, 1888. The following is an abstract.]

The following experiments, undertaken by the author, may be of interest as indicating the way in which the cheap generation of electrical energy may possibly be brought about.

In the first experiment, an element was formed through which heat energy was converted into electrical energy, in which the correlation of forces is beautifully illustrated.

It is a sort of voltaic battery, in which plates of tin and platinum forming the electrodes are immersed in a solution of chomic chloride, which has no action on the plates at ordinary temperature, so no current is generated. The cell is hermetically sealed, and when heated the liquor becomes active, and part of one of its elements, chlorine, leaves the chromic chloride, goes over and temporarily combines with the tin, forming a proto-chloride of tin. The chemical action generates an electric current, but soon the tin is all converted into chloride, and the current ceases. When the cell is cooled, this temporary combination of the chlorine and tin is broken up, and the chlorine returns to the chromium proto-chloride. The tin being set at liberty, falls as a metallic precipitate to the bottom of the cell in the form of beautiful crystals, ready to renew the combination when the cell is again heated. None of the materials of the elements are destroyed, they last an indefinite time. The chlorine changes from chromic chloride to tin and back as often as the cell is heated and cooled.†

It will probably be found that the solution of the tin absorbs heat, and so tends to cool the liquid, and the precipitation develops heat, and so tends to warm the liquid, and that the part where the solution occurs must be kept warmer than that where the tin precipitates. An investigation would probably show that when electric currents are generated the heat absorbed by the solution of the tin is in excess of that generated by the precipitation of the equivalent of the electrical energy developed, and that the possible excess is governed by the second law of thermo-dynamics. If the cell works between 80deg. and 180deg. F., the E.M.F. at the higher temperature is about 0·26 volt, the efficiency is less than 16 per cent., as the possible efficiency $= \frac{T-t}{T}$ reckoned from absolute zero, or $\frac{638^\circ - 538^\circ}{638^\circ} = 15{\cdot}7$ per cent. In fact, this cell is a heat engine, analogous to the thermopile, which is said to convert only 2 per cent. of the energy of the coal into electric energy. In practice probably nothing like 16 per cent. could be utilised.

By the second law of thermo-dynamics the minimum amount of heat that goes to the cooling agent is the fraction $\frac{t}{T}$ of the total amount employed, where t is the temperature of the cooler reckoned from the absolute zero and T the higher temperature of the working substance; t cannot be less than about 500 deg., so the numerator of the fraction is always large, and the heat wasted is the larger portion. Understand that this is the law of nature; it is inevitable under the conditions in which we live. No cunningly devised furnace, or feed-water heater, or cut-off, or triple expansion apparatus, or pyro-generator can save this heat. The most that any of these devices can do is to save what would otherwise be wasted over and above the proportion $\frac{t}{T}$. But are we to go on wasting all this energy of fuel? Cannot some means be employed to utilise it? We know that the voltaic battery is not a case of the transformation of heat into electrical energy; it produces electrical energy directly. The second law of thermodynamics does not apply, as no heat appears. If we could convert the chemical energy of coal and oxygen into electric energy, directly and cheaply, we would do away with all our steam motors at once. There is no known reason why a cheap substance may not be found which will act on coal and develop electric currents in place of heat. This electric energy would be the equivalent of the heat energy that would be developed by the combustion of the same coal in the ordinary way, and could be transformed into mechanical power, heat, light, &c., with small loss.

So far, little progress has been made in this direction. Some time ago Jablochkoff produced a battery in which plates of carbon and iron were immersed in fused nitre. The carbon being oxidised furnished strong currents. The objection to this element is the generation of heat through local action. To it the second law does not apply. Another battery of more interest than the first is an illustration of an element which is not affected by the second law; heat is not essential to its operation, as the energy due to the complete oxidation of carbon is converted into electric energy directly.

In a glass cell containing sulphuric acid, sp. gr. 1·81, temp. 75 F., two electrodes were immersed, one of platinum, the other of lump graphite; only a slight E.M.F. was indicated, 0·007 volt, due to the combination, the graphite acting as a positive element; on the addition of a small quantity of chlorate of potassium to the acid the E.M.F. immediately rose to 0·08 volt, the graphite being disintegrated after a time. This cell polarised rapidly, which was partially prevented by mechanical means. The reaction of chlorate of potassium with sulphuric acid may be represented by the following equation:—

$$3\,KClO_3 + 2\,H_2SO_4 = 2\,ClO_2 + KClO_4 + 2\,KHSO_4 + H_2O.$$

Potassic chlorate and sulphuric acid yield chloric peroxide, potassic perchlorate acid sulphate of potassium and water.

A method of exclusion was adopted to ascertain the oxidant of this electrolyte; chlorine peroxide (Clo_2) appeared to be the only active agent. It is decomposed by the carbon, chlorine being evolved with some oxygen. It was assumed that in this cell graphic acid ($C_{11}H_4O_5$) was formed as the result of the chemical actions. There is probably much waste of energy through local action, as the chemical reactions go on when the circuit is open, but to a less extent. In another experiment an electrolyte was formed of sulphuric acid and chlorine peroxide*, the gas being formed in a retort by the action of sulphuric acid on chlorate potassium, and conducted over into the acid in which it was dissolved. This cell, with a positive element of graphite, opposed to platinum, gave an E.M.F. of 0·7 volt.

A similar combination was used with a solution of chlorine peroxide in water as the electrolyte. The E.M.F. assigned to these cells is only approximate, as it was found dependent on the quantity of chlorine peroxide in solution, which was constantly changing. The resistance also varied with the different degrees of concentration of the exciting fluid.

Different forms of amorphous carbon were substituted in place of graphite in the first form of cell. Gas carbon gave an E.M.F. of 0·007 volt when opposed to platinum in sulphuric acid; on the addition of chlorate potassium the E.M.F. rose to 0·5 volt.

Carbon produced by the action of sulphuric acid on cane sugar in this experiment gave an E.M.F. 0·3 volt.

The carbon of animal charcoal, wood charcoal, coke and anthracite gave an E.M.F. variable with each form, ranging from 0·3 volt to 1·25 volt. The measurements of E.M.F. of the various combinations were made with the electrode immersed in separate parts of the same solution, that the concentration of the liquid and quantity of gas in solution might be as nearly equal in each cell as possible. It was found when the carbon in comminuted form was contained in a porous cup that the combination gave an E.M.F. of 1·24 volt, apparently due to the presence of the oxygen of the air.

It is impossible at the present stage of the investigation to assign any definite value of the E.M.F. to these forms of amorphous carbon. In some cases they appear to have an E.M.F. higher than that of graphite.

The energy of the combination of carbon and oxygen when completely oxidised to (CO_2) carbonic acid gas is stated to be 9624

* Great care must be taken in the preparation of this gas, as it explodes at a temperature of about 140 F. It can be preserved in the dark, and is decomposed by sunlight into its component parts.

† This cell has been described in *Proc. Roy. Soc.*, No. 244, 1886; *see* also *The Electrician*, August 6, 1886, p. 264.

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foot-pounds per grain equivalent, which is 2·0594 equivolts.* In these carbon elements the E.M.F. is not so high, as there must be deducted the counter E.M.F. or polarisation, and the energy due to the force of setting chlorine free.

Analyses prove that ($H_2SO_4 + KClO_3$) sulphuric acid + chlorate of potassium oxidises carbonaceous bodies to CO_2, and, further, that such bodies first are changed to compounds soluble in the acid (caramel-like substances), which are rapidly oxidised to CO_2.

Undoubtedly the direction of experiments in the future will be to find some substance which will absorb oxygen from the air and give it up to the carbon; in fact, acting as a carrier of oxygen, so oxidising it without heat; and this is not improbable, as we already know of substances which do this, though giving a low E.M.F., as, for instance, the ferric salts are reduced to ferrous by agitating their solutions with carbon, being regenerated by absorbing oxygen from the air.

By pursuing this line of investigation we can be sure we are not ignorantly striving against any law of nature when attempting to convert the whole potential energy of carbon into electrical energy.

* See Sprague's "Electricity," p. 519.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Jan. 7th*, 1888.

A Note in a recent issue of your paper gave an estimate of the number of telephones in use in the United States as 175,000. This, however, is very far below the actual figure. The number of telephones that were in use by the various sub-companies and licensees of the American Bell Telephone Company last week was no fewer than 378,885, making an increase for the year of a little over 25,000, and an increase over 1885 of about 55,000. The largest gain exhibited in the development of the telephone was in 1883, when the gain in a single year was about 60,000 instruments. The fact that the yearly increase now is so steadily large is good evidence that the telephone service, with all its imperfections, is appreciated, and that the rates are not prohibitive, as is so often claimed. It is amusing to see how the anti-telephone agitation breaks out or is fostered first in one place and then in another. The work is generally begun by some enterprising newspaper in search of a sensation, and Chicago has just given us an instance of this kind of work. The *Tribune* there, after a series of articles enlarging in the usual way on the "miserable service," "excessive charges," "unscrupulous greed," &c., proceeded to issue about 500 circulars to representative business people on the subject of telephone rates, asking what they thought about it. A copy of this circular happened, however, to fall into the hands of one of the other papers, which immediately made the campaign its own, sent out its reporters, worked up the interviews, and then rested in the blissful consciousness of having secured a "first-class beat." But while this may be delightful excitement for enterprising newsmen, it is a little annoying to the telephone company.

Some notable efforts are now being made here to utilise water-powers that have been more or less neglected on account of their remoteness from the place at which the power could be utilised. At Sault Ste. Marie the local Edison Company has been getting ready a plant which will utilise 1,800 horse-power, and which, as it has 32,000 square miles of water in Lake Superior to draw on, is not likely to suffer from drought. At St. Catharine's, Ontario, a new electric railroad on the Van Depoele system has gone into highly successful operation with a total equipment of ten motor cars operated by water-power. This road has available nearly 1,200 horse-power from the Welland Canal. At Ansonia, Ct., another Van Depoele electric road is being built, for which the generators are also to be driven by water-power. This road will not only carry passengers, but will also handle heavy freight. Besides these and many other projects of less imposing character there are two really big schemes on foot. One is a Californian project involving nothing less than the utilisation of the water power of the beautiful Lake Tahoe by means of an immense siphon. It is asserted that through the medium of electricity no fewer than 100,000 horse-power could be distributed from this source. Comparing with this idea is that of utilising the enormous power of the Niagara River, and it is understood that Mr. J. F. Kerns, who has an invention for that purpose, has been granted the use of 500ft. of Government frontage of the river to make his experiments. In this case, again, electricity is proposed as the great distributor, and despite the high price of copper it certainly seems to have a better chance than other agencies. Out West, by the way, an extensive use of Sprague motors is to be made in connection with mining operations and utilising water power.

Some light on the rapid development of the Westinghouse Company's alternating system is thrown by a compilation or table of central stations that has just appeared in the New York *Electrical Engineer*. The list comprises no fewer than seventy-two stations, which figure up a total of not less than 124,950 lights. These stations are in all parts of the country, and include such large places as Pittsburgh, Buffalo, New Orleans, Baltimore, Richmond, Minneapolis, Philadelphia, Denver, and Chattanooga.

Your attention has already been drawn to the fight that has been waging in Philadelphia between the city council and the electric light companies. The matter has been of unusual interest, because there has been so freely expressed on the part of many of the leading politicians and others in Philadelphia an intention to take the business away from the electric light companies, and to establish a plant to be operated by the city. As a general rule, propositions of this character are not viewed with much favour in America, and it does not now seem likely that even in Philadelphia the plan will be carried out. For the present there is a compromise, the companies having agreed to continue lighting their respective districts for the next three months at the prices named in their recent bids. It looked at one time as though an absolute deadlock would occur, and as a precautionary measure some of the old gas lamps along the leading thoroughfare, Chestnut-street, were actually refurnished with burners. There is no fear, however, of any definite return of gas, and the electric light system in Philadelphia is practically being extended about as quickly as any one could expect or well desire. In Detroit an attack made on the local Brush Company has virtually failed, the company having just closed a new contract with the city for a term of three years.

Some record was recently made in these notes of the work done here by the Subway Board. It may be added as an interesting comment on the difficulties in the way of moving the innumerable poles which we maintain in our streets as a reminder of the forest primeval which stood there not so long since, that the Board has succeeded in taking down the enormous total of 217 poles, chiefly from streets of which they were the main ornament, streets that by no possible stretch of language or imagination can be described as beautiful, streets to which, in fact, they gave an air of business that was hardly in keeping with the surroundings. It is promised that a great many poles are to fall within the next three months, after which time perhaps the Chinaman will have to find a new place for his advertisements and the Anarchist a new notice board for his inflammatory proclamations. The fact is, the Board is still at the very outset of its work. Over in Brooklyn the Subway Board has succeeded during the last year in removing 17 poles.

The National Electrical Light Association is to hold its next meeting at Pittsburgh, a city which is especially interesting at the present time to electricians, from the fact that it is now the home and head-quarters of the Westinghouse Electric Company. This meeting will take place in February. The summer one will be held, it is said, at Cleveland, the home of the Brush Company, and thus the association will have an opportunity of making an interesting comparison between the latest developments of electrical application and the earlier ones, with which the Brush Company, the pioneer in the field, is associated. One of the leading topics at Pittsburgh will undoubtedly be the alternating system, and probably some

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very interesting data will be contributed to the discussion by those who have been operating alternating current plants during the past year.

The latest addition to the list of "cable knights" is noted here with much interest. The recognition thus bestowed on the work and position of Sir John Pender is seen with pleasure, even by those who attach no importance to titles and by those who are in the opposition. I imagine that Sir John was the recipient of many despatches of congratulation from this side. It is thought, however, that while the powers that be were about it they might have conferred an honour adequate to the prominence of the man and the vastness of the interests he represents. We see not a few Colonial notables here, and it seems as though every minor functionary ruling over the destinies of some granite chip of an island gets the order of K.C.M G. If suggestions as to these matters may fitly come from Republican America, why does not Her Majesty create an order for rewarding distinguished services in the arts and sciences? Why should such men as Sir John Pender be lumped in with the Deputy-Lieutenant-Governor of Borioboolagha and the ex-Assistant Commissioner of Excise of Assamtee?

CORRESPONDENCE.

THE EMPLOYMENT OF PERMANENT MAGNETS FOR SIPHON RECORDERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In *The Electrician* of the 11th Nov. I notice a description of a permanent magnet recorder, exhibited by the Commercial Cable Company at the Electrical Exhibition in New York, and said to be the invention of Mr. Charles Cuttriss, that company's electrician. Will you kindly allow me space to say that as far back as October, 1882, I had a circular magneto recorder, identical in all essential points with the one described, working on one of the Anglo-American Company's cables at this station, and I soon afterwards submitted specimens of the signals received from Valentia, on that instrument, to Sir William Thomson.

The original drawings of the circular magnet which were made by me in 1881 can no doubt be seen at the works of Messrs. Paterson and Cooper, late of Little Britain, which firm made and delivered to me that form of magnet in July, 1882.

I believe that this form of siphon recorders are now made by Messrs. Elliott Brothers for some time past.

In April, 1885, my patent vibrator was placed on the recorder at this station, and has ever since worked well when required, and has proved a most useful adjunct to the recorder. I think, therefore, I may justly claim priority of the invention as far as Mr. Cuttriss is concerned, both for circular magneto recorder and vibrator.—Yours, &c.,

William Dickenson.

Anglo-American Telegraph Company's Station,
Heart's Content, Dec. 30th, 1887.

SIR WILLIAM THOMSON'S PAPER "ON THE APPLICATION OF THE DECI-AMPERE OR CENTI-AMPERE BALANCE TO THE DETERMINATION OF ELECTROMOTIVE FORCES OF VOLTAIC CELLS."

A Correction.

Sir W. Thomson will feel obliged if the Editor of *The Electrician* would kindly note in an early issue the enclosed correction.

The University, Glasgow, 17th January, 1888.

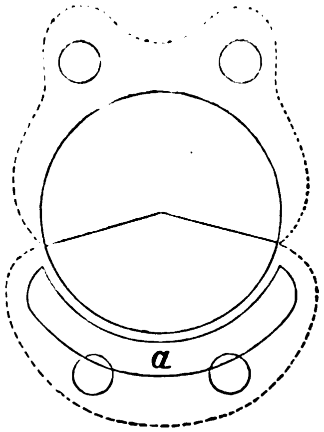
On account of the numerical error in this paper (see *Electrician* for December 16, 1887), pointed out by Mr. Desmond FitzGerald in a communication to a contemporary journal on January 6, 1888, referring to Mr. Gray's measurement of November of the electromotive force of Clark cells, constructed by Mr. Bottomley last March, substitute for the last four lines of the article the following:—"Correcting to 15deg. C. we obtain 1·4346 Rayleigh volts at that temperature. This result is interesting as showing a difference of less than $\frac{1}{10}$ per cent. from that obtained by Lord Rayleigh for similar cells, which was 1·435 at 15deg. C."

THE BALL UNIPOLAR DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of Dec. 9th, in a Note on the sparking of brushes, page 96, you make this remark in relation to the Ball unipolar dynamo:—"Of course we all know, on the other hand, that this machine never could, and never would, work according to any recognised theoretical assumptions."

As I at one time made a number of measurements and tests of Ball machines, when in charge of the electrical engineering department of the Cornell University, I shall have to differ with you in regard to that statement. The Ball machine not only can, but *does* work exactly as theory would indicate. Referring to the rough sketch which I enclose, the lines of magnetic force leaving the pole-piece *a*, and entering the core of the armature, must leave



it somewhere, and in the absence of the pole-piece on the opposite side, they leave it by the best and easiest path to be found. They go partly through the air across to the pole-piece of the opposite armature perhaps, but mainly to the two field cores which pass across over the armature, and so return to the first pole-piece through the mass of iron which makes up the field-magnets. The absence of the pole-piece over the armature simply causes a greater resistance in the magnetic circuit than would otherwise occur, less of the lines of force on the whole pass through the armature than would pass though it if both pole-pieces were used, and those which do pass through it pass out with more or less irregularity. They are concentrated under the round bars forming the field, and therefore develop a greater electromotive force in the coils of wire passing those two points, causing a certain amount of irregularity in the action of the different coils, and, therefore, very serious sparking at the brushes upon the commutator. By taking out the upper field magnet bars and turning them end for end, so that the pole-piece over the second armature was transferred to the first, bringing the one armature between the two pole-pieces, as in the ordinary Gramme machine, the number of lines of force passing through that armature, as indicated by the electromotive force developed, was nearly doubled. That is, the one armature alone gave, when between the two pole-pieces, almost the same electromotive force as the two armatures when acted upon each by its own pole-piece. An exploration of the magnetic field, by means of a special coil put upon the armature for that purpose, which gave the intensity of the magnetic field at each point in the circumference around the armature, showed a very strongly marked increase in the magnetic intensity under the bars on top of the armature

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where the pole-piece was absent, and showed also that the electromotive force of one polarity existed through less than 180° on the side that was acted upon by the pole-piece, and that the opposite polarity existed through something more than 180° on the other side, as shown roughly in the diagram which I send, where the dotted line is a rough indication of the strength of the field at different points when the armature itself was producing no current. The sketch is drawn from memory, and is only intended to show in a rough way what the condition of things was.

A great deal has been said about this Ball machine, but I have not seen anything in it that is strange or unaccountable. The only thing surprising about it is the fact that so great an output is obtained from these machines for so small a weight. This is largely due to the fact that comparatively fine wires are used, which make the internal resistance of the machine rather high, and therefore reduce somewhat the efficiency. The machine is, however, fairly efficient, and so far as the efficiency of conversion is concerned is equal to any of the best machines. In other words, the local action in the machine has been reduced to a very small amount, and the claim which the inventors make is that it is the reduction of the magnetic field by using only one pole-piece over each of the armatures that enables them to obtain so small a degree of local action. They put it in this way, that if they were to put the one armature between the two pole-pieces, thereby nearly doubling the intensity of the field, as was shown by my experiments, the local action in the armature core would be nearly doubled, and they would, therefore, have to run at a much slower speed to prevent heating of the core that would otherwise occur, and therefore they would be unable to obtain from the one armature so great an output as they now do from the two. But this is not a point that I care to discuss. The object of this letter is to point out that the machine works like any other dynamo, differing from them only in the fact that the field is a very irregular and unsymmetrical one, and, therefore, causes a serious sparking at the brushes, which always must result from any such want of symmetry.—Yours, &c., WM. A. ANTHONY,

Electrician to the Mather Electrical Company.

Manchester, Conn., January 5th, 1888.

[We venture to think that Prof. Anthony's remarks as to the output of this machine rather tend to bear out our previous observation; it is at least clear that the mere employment of fine wire in the armature (entailing increased self-induction) cannot possibly increase the output unless the current density is correspondingly increased. On the other hand, it is quite in accordance with the experience of dynamo builders in this country that *in a weaker field* it is possible to employ a higher current density without overheating the armature, and it is obviously not difficult to account for this theoretically.—ED. *E.*]

MR. STANLEY ON THE PHENOMENA OF RETARDATION IN THE INDUCTION COIL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In a paper read recently before the American Institute of Electrical Engineers, by Mr. W. Stanley, jun., attention is called to what I had believed to be an exploded theory. "Phenomena of Retardation in the Induction Coil" is the title of the paper, and the lag of current behind the E.M.F. is explained on the supposition of a magnetic lag in the iron core. Such an apparent ignorance of the elementary principles in so successful an engineer as Mr. Stanley undoubtedly is surprises me greatly. I had thought the experiments of Silvanus Thompson, Mordey, Willoughby Smith and others had settled this point long ago. Without criticising the paper as a whole, I will draw attention to a salient point which should not pass without notice in our scientific journals.

In the curve of E.M.F. of a coreless armature, Mr Stanley says the effect of induction is *not* to cause a lag, but only to lower the value of the E.M.F. at each moment. This, I fancy, will be news to most of your readers.

Mr. Stanley admits that induction causes lag with an iron core. So it would seem that there are two sorts of induction, one of which lowers the value of the impressed E.M.F., whilst the other only tends to delay it.

Mr. Stanley has done too good work to make such statements without due consideration, and I should be glad if you, Sir, can explain the matter.—Yours, &c.,

ALBION T. SNELL.

[We may refer our correspondent to some observations in our editorial columns.—ED. *E.*]

INDIA RUBBER COMPENSATORS FOR OVERHEAD WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was much surprised to find in last week's edition of the *Electrical Review* a Note which refers to the perfect uselessness of my invention, described in your valuable journal of the 6th inst., upon the grounds that "less than a year's exposure to the continual action of wet and dry heat and cold would completely perish the rubber." How is it, then, that the rubber springs on tram cars last on an average for five years exposed to all weathers and rough usage? In order to answer this question to my best ability I am of a belief that india rubber, as long as it is in a state of vibration, will not solidify or become inelastic for some years; but, on the other hand, if allowed to remain exposed and inactive it will soon become hard or perished, because the vibration tends to prevent the molecules from combining to form an inelastic mass.—Yours, &c.,

144, Kennington-road, S.E. R. G. BOZON.

THE SKRIVANOW CELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I wish to prepare a small cell for an electric star light. Munro and Jamieson, in their pocket book, recommend the Skrivanow cell, but I want some directions how to place the chloride of silver in the cell. Would you, or some of your readers, kindly oblige me?—Yours, &c., P. T. H.

Nystad, Finland.

[We believe that the chloride is made into a paste with a 4 per cent. solution of caustic potash. This is placed round the silver plate, and the whole is wrapped with parchment paper. When the battery is exhausted (*i.e.*, the chloride reduced to spongy metallic silver), the paper is taken off, and the plate dipped in dilute nitro-hydrochloric acid for a time, which re-forms the chloride.—ED. *E.*]

TELEGRAPHIC INVENTIONS AND THEIR INVENTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following list of inventions and their inventors covers a large part of the whole ground of the marvellous march of telegraphic science which our age has witnessed:—The Needle Telegraph, Cooke and Wheatstone; the Morse Alphabet and Printer; the Siemens Printer; the Wheatstone Printer; the Duplex System, Gintle, Siemens, and Stearns; the Quadruplex System, Stearns and Edison; the Multiplex System, Delaney; the Telephone, Bell and others; the Neutralisation of Induction by Crossing the Line Wires, Prof. Hughes.

So far as I am aware this list does not include the names of any who are now or have at any time been employed as telegraphic engineers by the English Post Office. Yet in your recent remarks on the spring shackle invented by Mr. Caws, and on the compensator invented by Mr. Bozon, you argue that such appliances would have been invented by the Post Office engineers had they been really necessary.

I cannot doubt that the Post Office engineers and electricians have rendered most invaluable aid to science by those practical and experimental works for which they possess exceptional

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facilities; but, judging by the above list, history does not justify us in looking to our public officials, but rather to outsiders, for new ideas.—Yours, &c., G. W. ERRINGTON.

[Mr. Errington appears to overlook the fact that the Post Office officials cannot patent their ideas; if they could his list would be largely increased; and even as it stands, the major portion of the inventions mentioned have become obsolete, at all events in their original form, their adaptation to modern wants being due entirely to Departmental ingenuity.—ED. *E.*]

MEDICAL ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have noticed in your paper of late several communications which are evidently inspired by a person who was in our employment for a few weeks, and who writes these effusions out of pure pique and spite.

We are somewhat surprised that a respectable scientific journal should open its columns to such abuse, which, considering the status we hold both with the public and the profession, is not calculated to do us the least harm.

The signed letter in your issue of the 6th inst. is a pure fabrication from beginning to end; but we do not intend to give this individual a cheap notoriety by an action for libel, in which we should undoubtedly be successful, but should nevertheless be unable to recover even our costs.

Trusting you will give this letter the same publicity that the thinly veiled attacks upon us have obtained.—Yours, &c.,

C. B. HARNESS.

The Medical Battery Company (Limited),
52, Oxford-street, Jan. 12, 1888.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

MR. EDWARD GRAVES' PRESIDENTIAL ADDRESS.

(*Concluded from page 248.*)

The use of the telegraph is not at all in proportion to the population of the various localities it serves. Much depends upon the nature of such populations, on the avocations in which they are mainly engaged, and the extent to which fluctuations are liable to occur in prices of the commodities in which they are interested. A certain constant quantity, as it may be considered, of telegraphic business arises from the needs of domestic life. This is common to all centres, but necessarily varies as the class of the inhabitants varies. From the east of London, for example, 500,000 residents have occasion to communicate by wire on their ordinary affairs much less frequently than a corresponding number of residents in the west. Speaking as a general rule, the operative classes of the community have less widespread interests than those placed higher in the social scale. They receive in relation to their numbers fewer letters per head, and send fewer telegrams. The employment by them of the speediest engine of communication is decidedly on the increase, but it has still great room for growth.

London is far and away the centre of greatest telegraphic activity; but the fact of its being the capital—the seat of the Legislature and of the Law Courts the headquarters of the Stock Exchange, and so on—gives it so many special features, independent of its widespread commercia interests, that it can hardly be properly compared with any provincial town as regards the amount of business done. It may, however, be of some interest if I contrast a few of the leading provincial towns in this respect.

Taking the calculated population within the free town deliveries of letters up to the end of 1886, and the actual number of telegrams originating within the same limits for the year ended September 30th, 1887, the results are as follows:—

	Population.	Telegraph Messages.
Glasgow	740,000	1,444,741
Liverpool	730,000	2,268,062
Manchester	613,982	1,660,538

exclusive in all cases of the messages collected for America and the Eastern Telegraph system, which are despatched by special wires worked by the cable companies. Upon these figures it should be remarked that the population attributed to Glasgow includes the ring of minor boroughs excluded from the city in a municipal sense. In the case of Liverpool all north of the Mersey is reckoned, but Birkenhead, largely peopled by persons interested in Liverpool commerce, is excluded. But the fact remains that the seaport possessing the largest trade of any, out of London, in the kingdom, does the largest telegraphic business. Manchester includes Salford in its number of residents, and, being a central point for numerous surrounding towns who look to it for guidance in commercial matters, ranks considerably above the larger population of Glasgow as regards the employment of the telegraph. Further—

	Population.	Telegraph Messages.
Birmingham	420,000	672,714
Edinburgh (with Leith)	319,030	667,758
Dublin	319,000	582,083
Newcastle-on-Tyne	151,500	546,294
Bristol	227,127	466,412
Hull	186,290	452,921

show the comparative telegraphic pre-eminence of the seaports as compared with the subordinate capitals and the great Midland manufacturing centre. Edinburgh, including Leith in its boundaries, adds thereby a place of material commercial activity to its semi-metropolitan population.

Other cases strengthen the conclusion that the nature of the trade rather than the absolute volume of business must be considered in determining this comparison, thus—

	Population.	Telegraph Messages.
Leeds	296,108	337,998
Belfast	225,000	344,603
Sheffield	305,000	257,056
Nottingham	211,424	236,143
Leicester	127,500	188,890
Cardiff	115,000	394,891
Dundee	152,840	206,168
Aberdeen	113,212	206,680
Newport (Monmouth)	40,000	153,193

For most of these divergencies and discrepancies persons familiar with the characteristics of the various towns will easily find reasons; and I may add a few more instances—

	Population.	Telegraph Messages.
Portsmouth	132,659	154,905
Plymouth (*ex* Devonport)	96,142	185,454
Southampton	61,000	158,069
York	60,500	126,541
West Hartlepool	32,000	114,014
Oxford	44,000	86,524
Chester	40,340	98,721
Bath	57,000	81,126

Analysing the figures given above, we find that Liverpool, with rather more than 3 messages per annum per head, Newcastle-on-Tyne with rather more than 3½ messages per head, Cardiff with somewhat less, Newport (Monmouth) with an approach to 4 messages per head, and West Hartlepool with about 3½ messages per head per annum, rank highest among English towns as contributors to telegraphic employment. It may be remarked that Oldham and Blackburn, both containing over 100,000 of population, do not figure in the list of the 52 towns whence the greatest number of messages are forwarded, although many much smaller places do so.

In some instances apparently extraordinary results are explained by local facts. Thus, the 60,500 residents of York apparently do much more business than the 91,000 inhabitants of Norwich, a city of the same general character (126,000 messages to 89,000); but probably the circumstance that two important race meetings are held at the former place, and that the great railway station there is far more important to the travelling community than any at Norwich, may account for the distinction. If it were possible to analyse the apparent discrepancies between the figures of other towns, no doubt there would be some similar means of explaining them.

This much may serve to illustrate the changes that the electric telegraph has wrought, and the benefits it has conferred.

The operations of the telephone as yet are of a more limited character, but even as at present developed are of little less interest. The telegraph may be regarded, in the main, as the rapid public transmitter of private or public correspondence; the telephone as the instrument of personal, and therefore strictly private, communications between man and man. If the communication is perfect, and so arranged as to be free from interference, not only can the varying sounds of voices be recognised through the connecting wire, but the tones may be distinguished in many cases, and the speakers known. One individual can speak freely to another, obtain his answer, and make any rejoinder he thinks fit. An entire business transaction can be completed without any pre-arrangement, and confidential questions can be equally confidentially replied to. Reis advanced the discovery of the means of transmitting the effects of speech to the verge of success, but did not pass the verge. Bell completed what Reis had begun, and placed a workable instrument at the disposition of the world. Edison and Hughes strengthened the forces employed for the transmission of sound waves, and the telephone (as we know it) was completed. Founded upon the laws that guided the production of the telegraph, the generation of the telephone was especially rapid—but a brief space has elapsed between its inception and its realisation. The marvels it has wrought are less striking than those of the telegraph, but the processes by which they are produced appear more marvellous still. At present the operation of wide-stretching patents perhaps cramps, to some extent, the improvement of the mechanical apparatus needed for telephonic expression, and time has not sufficed to admit of all difficulties in the way of its extended use being overcome; but seeing how few years have elapsed since the discovery of the thing itself, we may reasonably hope for its much greater development in the near future.

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EMPLOYMENT ARISING OUT OF THE VARIED USES OF ELECTRICITY.

There are many indirect methods in which labour is employed, because electricity has been utilised, that do not admit of being ranked under any special head of its operations. Wire drawers, and, in consequence, iron works, and copper smelting works, also copper plate rollers, are largely engaged in the production of materials for the transmission of electric signals. Timber dealers and their workmen, creosoters, insulator makers and their *employés*, brass workers, spelter makers, engine builders, boiler makers, glass blowers, carbon plate and rod manufacturers, and very numerous other occupations, receive considerable employment by means of the demands that electricity has encouraged; but as the firms engaged do not generally devote themselves solely to meeting such demands, but exist also for wholly distinct purposes, it is impossible to arrive at any idea of the amount of labour on electrical account that they employ. It is equally impossible to enumerate all the persons engaged in absolutely electrical trades. In Sheffield there are 172 electro-plating and electro-gilding manufacturers, employing in all about 5,000 hands; and in Birmingham there are 99 manufacturers of the same class, two of whom employ 300 persons each, and others a large, though uncertain, number in the aggregate—one thing is certain, it must in the total be very large.

The electroplaters, electrotypers, and the like are so widely spread that it is impossible to collect reliable figures for them—the instances preceding must suffice; a similar conclusion to the former is only possible. It is the more difficult to arrive at any satisfactory determination because it is simply impossible to ascertain how many persons were employed in dealing with the old methods of working in these directions.

In London alone there are, according to the "Post Office Directory" of 1888, 535 commercial firms, of greater or less magnitude, engaged in various operations of which electricity is the main spring. Some of these firms appear under several trade descriptions, and it is impracticable to assign any reliable figures to the number of their *employés*, but in the total it must be very considerable. Each employer, although carrying on probably several distinct branches of trade, must engage the full time of various persons, in most cases, in each distinct branch. To the London employers must be added the numerous others existing in our provincial towns. I have, however, obtained reliable figures wherever possible.

I will first take the case of the British Inland Telegraphs.

The English Post Office employs solely in the conduct of telegraphic operations 18,303 persons. These individuals give *all* their time to work in connection with the electric telegraphs; many thousands of others are partially employed in the same work, but they discharge other duties also, and possibly would be required for those duties did not the telegraph exist. I have therefore not included them as among those who have found their means of subsistence through the operations of electricity.

To this ascertained number must be added those who are employed by the various railway companies, either in the conduct of their general telegraphic business between station and station, in special duties in connection with the signalling of trains, or in upholding the telegraph lines existing on the different railways. I could not, in the time available, get the figures I wanted from every railway company. I therefore contented myself with those of four great companies, whose entire systems extend over a length of 5,881 miles. I found that they employed 1,627 persons solely on telegraph work, and, as the entire mileage of railways existing in 1887, as given in "Bradshaw's" handbook, was 19,339 miles, I apply the rule of proportion, with the result that I find the total number of railway servants wholly engaged in electrical work to be 5,383. Many of the railways which go to make up the gross total mileage are small concerns, many are large ones; but as the infinite subdivision of lines multiplies the number of persons employed in carrying out the operations of any branch of work, I do not think that I can be far wrong in applying the ascertained results of the figures I have reliably obtained to the average of the whole railway system.

But, like the Post Office, the railway companies have a very great number of persons partially though not wholly engaged in similar operations. The men at the numerous signal cabins not only work the levers controlling the fixed signals, but usually manipulate the block telegraph besides. At many small stations, where there is but a limited force engaged for the discharge of all duties, the booking clerk works the instrument in addition to his other employments. I do not count either of these classes among the purely electrical *employés*.

The Exchange Telegraph Company, a licensee of the Post Office, engaged mainly in the supply of intelligence of special events to clubs, public institutions, and private persons, employs the entire time of 182 persons, besides the partial time of many others who supply the company with reports and information.

Thus the number of individuals engaged entirely in the transmission of business brought about by the existence of the electric telegraph in Great Britain and Ireland is, as nearly as I can ascertain, 23,868 persons; to which must be added an army of persons who probably find their incomes more or less considerably increased by the same cause, though not entirely dependent upon it.

I intended to confine myself to the economical figures of the British Islands only, but I may remark that if the rule of proportion holds good in this branch of the subject, and the entire mileage of public telegraph wires of all kinds in this country be, as is the case, 229,000 miles or thereabouts, while those of the world approximately amount to 1,800,000—omitting submarine cable—we have, as in the one case 23,868 persons are employed, a total number of 179,748 persons who find a field of labour in the working of telegraphic communication throughout the globe. It is impossible, seeing the varied circumstances existing in different countries—in some there are long mileages of wire connecting comparatively few offices or stations, in others there are short mileages connecting many stations—to say that this total is correctly arrived at, but it cannot fail to be at least an approximation to the truth. In some countries the available figures are indefinite as regards the differences between Governmental lines and wires for railway purposes; in some, telephone lines are mixed up with the figures for telegraph lines. Thus the totals I have given are liable to error, but it is, at any rate, error on the right side, and the number of individuals engaged in their working in all probability will rather exceed than fall short of the numbers I have given. The facts as to the partial employment of individuals not enumerated as telegraphic *employés* is common to all the world, and not by any means limited to the United Kingdom. To the known and fully occupied a very large addition must be made to represent the unknown and partially occupied.

The Submarine Telegraph Cable Companies must next be considered. From three of these—the Eastern, the Anglo-American, and the Submarine—I have obtained the actual figures. Their *employés* number in all 2,168. These three companies possess about 36,697 miles of wire, and throughout the globe there are about 107,000 miles of cabled wire. Deducting those cables that are really integral portions of land circuits and which have no separate organisation, the persons employed in working them are treated as if engaged on land telegraphs. By proportion, this total mileage of wire in cables should make the entire number of persons employed 6,315. Some time ago the Eastern Telegraph Company endeavoured to get up a census of the number of persons employed in submarine working throughout the world, and arrived at a total of 4,844 persons; but I am not certain that all the lines included in the above calculation were existing at the time such census was compiled. I am pretty sure they were not. I take the actual total of persons employed at 6,000.

These cable companies employ also cable ships in repairing and maintaining the submarine lines. Of these I speak more fully when dealing with cable manufacturing companies.

Next in order come the Telephone Companies. These, in proportion to the number of their wires, of course employ comparatively few persons, as the renters of the lines are their own manipulators; they employ attendants only at exchange switches; but, nevertheless, the information received from all the companies existing in Great Britain and the North of Ireland shows that their operations give employment to 2,386 persons. To this number must be added that of the company working in Dublin and the South of Ireland; thus the total is raised to certainly 2,500 individuals, probably more. I have no facts upon which I can extend the comparison to the world generally, but, seeing the universal adoption of this means of communication, and the extent of its development in the United States especially, there can be little doubt that the aggregate total of persons engaged in carrying out this form of electrical undertaking must at least reach 30,000.

The electric lighting industry then comes under consideration. From five of the largest concerns engaged in the business of either providing apparatus and mechanism for its production, or utilising such means for the actual installation of the illuminant, I have received returns of the average number of their *employés*. These amount to 1,828. The five concerns I applied to, although among the largest, by no means represent the greatest part of the entire industrial army occupied in the like pursuits. I believe that there need be no hesitation in putting down at least 5,000 as the total for our country; and, keeping in mind the fact that all countries welcome and adopt the new light—some to an extent much exceeding our own—it is reasonably certain that twenty times this number, or 100,000, will not be too great a figure to represent the entire strength of the workers in this field. Along with the electric light companies and the employment they give, I comprise those of the makers and producers of secondary batteries or accumulators mainly occupied in operations auxiliary to the production of electric light.

There remains to be considered the number of persons employed by the submarine cable and insulated wire manufacturing companies, who most of them make also various instruments used in telegraph working, and in other electrical applications. The extent of the employment given by them varies considerably, as, of course, cable making is a somewhat fitful industry—the periods of active construction and of comparative slackness alternate with each other. From the three largest companies on the Thames, I learn that the average number of persons employed by them varies from 5,457 at a busy time to 1,803 at a dull one. This gives an average of 3,630. The trade, so to speak, is more concentrated than in the case of the electric light, and it is probable that about 5,000 persons will be a fair allowance for the entire number engaged in it in these realms.

In the foregoing totals are included the number of persons habitually employed on the cable-laying ships of the various manufacturing companies, as is also the case with the repairing ships belonging to the different cable companies. The vessels represent a kind of international fleet engaged solely in attendance upon the cables in which their owners are interested. They are of all sizes, from the gigantic "Silvertown," "Faraday," and "Scotia," to vessels of 300 tons and 400 tons burden. Our mercantile marine, therefore, must be counted among the occupations benefited by the advent of electricity.

We must not overlook the large body of persons engaged in teaching the aspirants to electrical knowledge. At universities, colleges, and technical schools a new branch of science has been added to the previous curriculum. Professors, demonstrators, and their assistants represent in the whole a very important and numerous class. Their pupils, in an appreciable measure, represent workers ranked in one or other of the occupations I have mentioned, while numerous others have as yet attached themselves to no special field of work, but are preparing to take part in some definite sphere of labour when their studies are sufficiently advanced. It is amongst these regularly trained for the conflict that we must look for our future victories over the inert forces of nature. It is they who will advance that which as yet is struggling with the difficulties that surround the unknown. It is to them that we must look for future discoveries

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which will make that plain and easy which now has to be sought for through much trial and many errors. In the early days men groped in the dark towards the light, as it were; but our present students of electricity have at their disposal a clear *résumé* of all the achievements of the past to aid them as a torch on their way to fresh operations in the same field.

Finally must be mentioned the technical press. Independently of the papers devoted mainly to other interests, such as the *Engineer*, *Engineering*, and their like, which give large space to electrical subjects, we have in England, America, France, and Germany alone between twenty and thirty organs interested wholly or specially in the publication of facts or opinions concerning the operations of electricity. This department of the press is invaluable in rapidly spreading a knowledge of what is doing by various workers in the electrical field throughout the globe, and is itself a literary outgowth of the marvellous agent we are regarding.

Considering the foregoing figures, the results come out as follows:—

Employed in connection with	Number of Persons.		Probable No. of Persons employed throughout the world.
British land telegraphs	23,868	....	180,000
Submarine cable companies (mainly British) ...	6,000	....	—
Telephone companies	2,500	....	30,000
Electric lighting	5,000	....	100,000
Cable-making and allied businesses	5,000	....	—
	42,368		

Add to these the individuals that cannot be classified, who must amount in the aggregate to at least an equal number, we arrive at a total approaching 100,000, in round numbers, of persons dependent for their employment on the various operations directly connected with electricity in these islands alone, besides a very large addition to the output of various trades, caused by its consumption of the materials they produce. The employment of 100,000 persons means the support of at least 300,000 of the community. An unusually large proportion of young, or at least unmarried, people of both sexes minister to the calls of electrical work, and hence I take the average family at three instead of the usual calculation of four and a-half or five.

If these figures represent even an approach to the truth, it is evident that throughout the earth there must be 5,000,000 of people at least who would have to seek for other means of subsistence if electricity and its commercial applications had not been made known to man. Thus it is evident that a double blessing has been conferred by the discovery of its potent force—a blessing to the inhabitants of the world at large, who profit by its operations, and a further blessing to the toiling myriads whose field of labour lies in carrying them out. How great will be the numbers similarly occupied and similarly dependent when a century more has rolled away!

Thus far I have sought to sketch, although briefly and imperfectly, the various modes in which electricity is utilised, and to arrive at some idea of the extent of employment derived by the workers who strive to secure such utilisation. But this is at best an approximation to the truth at the present moment. It is little more than fifty years since the powers of the new agent were first turned to practical account, and since that time the record has been one of continuous and unabated progress. Discovery has succeeded discovery, and invention has followed upon invention. At present many fields are entered upon but scarcely trodden. Electro-motors and their like have clearly an unknown, an immeasurable field before them. What is done is as nothing to what will be done. The fusion of the influences of sound and light, the laws of heat in relation to the power we are considering, and its equally important bearing upon those of acoustics, open up so many directions in which we may look for future researches to make much that now shows, as it were, through a glass darkly, clear and distinct, if not to ourselves, at least to future generations. The Leyden jar and the frictional machine taught us the true resemblance between the force they made manifest and the awe-striking lightning discharge from the clouds. Later, more tractable and more easily controlled manifestations of the same agent have been discovered, but in their obedience to control they enlarge greatly the sphere of its uses.

As a stander-by, watching the progress that has been made, and is still making, by the earnest workers who have given to the world so much—marking the difference between the knowledge of the present day contrasted with that which existed over thirty-six years ago, when I first knew the difference between a battery and an insulator, and conceived some vague idea of their respective functions—I am struck with astonishment. In 1852 the Rubicon had been crossed, the theorist had given place to the practical worker, but as yet the latter had not advanced very far from the lines laid down by his predecessors; the spirit of the originators was as yet the controlling influence, but the mind of the student was set free, and each month showed the results of unshackled inquiry. Now fields, undreamed of then, have been opened; new applications have been discovered by which the powers of electricity have been utilised; known applications have been greatly advanced and extended. In the time of which I speak comparatively few of the *employés* in telegraph working—and that, was speaking broadly, the sole demonstration of electricity that could be commercially cultivated—were attracted thereto by any knowledge of the science upon which it was founded, or interested in the progress it might make; most looked to it as something in the operations of which they could contribute with profit to themselves, remaining ignorant of the laws that governed it, or the reasons why certain apparatus was employed to produce its effects. To them any knowledge they might glean was empirical, the pure result of experience in a contracted form. At the present day an entire change has taken place. Into none of the advanced operations of electricity does a youth engage himself without having some taste or liking for investigation and the acquisition of real knowledge of the subject in which he is interested. Societies such as this best justify their existence in lending aid to those who seek to elevate themselves and to know what can be learned from their predecessors in kindred labours.

A distinguished scientific statesman once described the mere *workers* of electric telegraph machines as "ambidextrous monkeys"—they knew only that moving a certain handle to the right or to the left, or a key up and down, produced signals or marks that were legible at the further end of a wire; but how they produced them or *why*, they were supremely ignorant. It is not so with the student of modern days. The man who devotes his life to the electric light, motive power, or other allied branches, knows that he must prepare himself by a careful course of theoretical study before he undertakes practical work. He must know the reasons for all that he does.

Thus, it is clear to me that in the facts detailed lies the strongest justification for the proposed alteration in the name of our society. In the summary of electrical operations which I have put before you I have given the largest space to the electric telegraph and its results. I am justified in so doing, because the telegraph is the most nearly completed of all the branches into which the laws of electricity are directed. No doubt there is still room to improve its processes, but its pioneer work is done, and it is scarcely possible that the future can yield more than progress, however important, in details. When the society was first founded, "Telegraph Engineers" was a fitting name, as it was only in telegraph engineering that any considerable number of the followers of the science we are considering were actively engaged. A great change has taken place; positively even more important than it was then, it is now relatively less so. The field has been so carefully reaped that it offers little temptation to the average gleaner. Speaking generally, men's thoughts are directed to other channels, where they may seek, in partially explored or unknown regions, the fame and profit that may accrue to those who win victories therein. "Telegraph Engineers" are still the most numerous units in our body, but from the force of circumstances they can no longer be said to be the special representatives of its character. The Institution of "Electrical Engineers" is a title comprehensive enough to include all devotees of the science; no class of workers is singled out for undue prominence, no class is by implication excluded.

The President of the Royal Society, in his recent address, told the members of that learned body that the world wanted a great discovery—that it was most desirable that the nature of electricity should be made known and defined. We may be on the eve of such a discovery, we may be far from it. The problem to be solved—that of the true character of the mysterious agent that seems to pervade all nature—ranks apparently with the equally puzzling one, "What is the soul?" Philosophical and theological students have quarrelled over the latter question for many generations without advancing nearer to a solution. Let us trust that "What is electricity?" may, in the fulness of time, receive an answer which will extend the boundaries of its use to purposes as yet undreamed of, and that the benefits it confers on man may be thereby multiplied many fold.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

224. E. BÖHM. London. Improvements in electric incandescent lamps. January 6, 1888.

225. H. ABBOTT and J. DOUGLAS. London. An improved portable electric battery for miners' and other lamps. January 6, 1888.

227. J. S. LEWIS. Helsby. Improving telephonic exchange magnetos or electricity generators. January 6, 1888.

242. J. H. DAVIES. Clapham. Improvements in electrical measuring instruments. January 6, 1888.

249. J. F. ROE. London. Improvements in electric meters or apparatus for measuring and registering electric currents. January 6, 1888.

293. T. PARKER. Manchester. Improvements in alternating-current dynamo electric machines. January 7, 1888.

295. T. PARKER. Manchester. A new or improved electric meter. January 7, 1888.

296. T. PARKER. Manchester. Improvements in switches for electric circuits. January 7, 1888.

302. T. PARKER. Manchester. A new or improved electric meter. January 7, 1888.

366. C. D. ABEL. London. Improvements in electric arc lamps (Siemens and Halske, Germany). January 9, 1888.

396. J. G. LORRAIN. London. New or improved apparatus for converting alternating currents of electricity into continuous currents. January 10, 1888.

416. J. H. TUCKER. Birmingham. Electrical measuring instruments. January 10, 1888.

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424. J. G. Lorrain. London. New or improved apparatus for converting alternating currents of electricity into continuous currents. January 10, 1888.

472. W. Webster. London. Improvements in apparatus for treating sewage and other impure liquids by electrolysis. January 11, 1888.

506. C. M. Dorman and R. A. Smith. Manchester. Improvements in the construction of suspension fittings for incandescent electric lamps (complete specification). January 12, 1888.

507. E. Berg. Berlin. A repetition and controlling signal telegraph. January 12, 1888.

531. H. Edmunds. London. Improvements in and means or apparatus for and connected with the generation, distribution, measurement, and control of electricity. January 12, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

Note.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

January 14, 1888.

1,904. G. Kapp, W. H. Snell and J. V. M. Kent. London. Improvements in the construction of transformers. February 7, 1887.

2,130. F. Jehl. London. Improvements in electrical inductors and commutators therefor. February 10, 1887.

2,134. A. Schanschieff. Surrey. Improvements in miners' safety lamps and in galvanic batteries especially suitable therefor. February 10, 1887.

3,560. E. C. Warburton. Manchester. Improvements in holders and fittings for electric lamps. March 9, 1887.

3,611. G. Forbes. London. Improvements in laying electrical conductors underground. March 9, 1887.

3,782. E. Edwards. London. Improvements in electric telegraph (D. Kunhardt, Germany). March 12, 1887.

3,785. E. W. Beckingsale. London. Improvements in junctions and testing boxes for electrical conductors. March 12, 1887.

3,917. C. Wittenberg. London. Improvements in registering apparatus for use in connection with telephones. March 15, 1887.

9,725. W. P. Thompson. Liverpool. Improvements in dynamo-electric machines (G. Westinghouse, United States). July 12, 1887.

14,260. S. C. Drew. London. Means for preventing induction in telephonic circuits. October 20, 1887.

15,588. J. Y. Johnson. London. Improvements in dynamo-electric machines (W. C. Reihniewski, France). November 14, 1887.

16,558. A. Wright. London. Improvements in apparatus for measuring and regulating electric currents. December 2, 1887.

PATENTS SEALED.

January 6, 1888.

17,084. A. R. Bennett. Edinburgh. An improved board for mounting telephonic switches and other electrical apparatus. December 30, 1886.

13,245. E. Graefe. Berlin. Process and means for placing railway trains in communication with an electric conductor separate therefrom. September 30, 1887.

January 10, 1888.

15,831. F. E. Elmore. Surrey. Improvements in or connected with means and apparatus for the deposition or obtainment of metals by electrolysis. December 3, 1886.

5,292. H. J. Allison. London. Improvements in electric motors (The Baxter Manufacturing and Motor Company, United States). April 12, 1887.

5,462. W. H. Scott and E. A. Paris. Norwich. Improvements in dynamo-electric machines. April 14, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

17,018, 1886.—A. H. Smith. Transmitting electric current in electric rail or tramway systems. (Price 1s. 6d.)

700, 1887.—S. Z. De Ferranti. Electric furnaces, &c. (Price 8d.)

6,853, 1887.—R. W. Eddison, Tatham and others. Metal cased electric lines. (Price 6d.)

15,653, 1887.—H. H. Lake (The De Mier Electrical Train Signal Co.). Electrical apparatus for railway signalling, &c. (Price 11d.)

15,730, 1887.—J. Vaughan-Sherrin. Galvanic batteries. Price 6d.

CITY NOTES, &c.

West India and Panama Telegraph Company.—The estimated traffic receipts of this company for the half month ended the 15th January are £2,509, as compared with £2,976 in the corresponding period of 1887.

COMPANIES' MEETINGS.

Eastern Telegraph Company (Limited).

The thirty-first half-yearly ordinary general meeting of the Eastern Telegraph Company was held on Thursday, at Winchester House, Old Broad-street, under the presidency of Sir John Pender, K.C.M.G.

The Secretary (Mr. Geo. Draper) read the notice convening the meeting, and the report of the Directors was taken as read.

The Chairman said that the revenue for the half year ended September, 1887, had amounted to £291,265, or £964 less than for the corresponding period of 1886. The Directors, however, considered that satisfactory, because the larger decrease of revenue caused by the reduction of tariff to India was sensibly diminished, and, indeed, the improvement of traffic with Australia, China, and other countries in the Far East had more than recouped the loss on Indian messages. Their traffic with Egypt, on the other hand, showed a further falling off; but that had been made good by the increase of messages exchanged with Portugal and South America. Having so many points for the interchange of traffic, they found that the loss sustained in one direction was sometimes made up by gain in other directions. For the current half year their prospects were most favourable. Their traffic now showed a small increase every month, and it was hoped that next July, when they presented their accounts for the financial year to March 31, they would be able to give the shareholders a bonus in addition to the 5 per cent. dividend. The total working expenses had amounted to £79,936, or £1,095 less. The general expenses in London had been £8,012, being £48 more. The working expenses at the stations had been £56,386, showing a decrease of £1,743. The principal reduction, however, was in repairs and renewals of cables, which had amounted in the past half year to £34,102, or £19,863 less. Therefore, after charging all expenses, including income-tax, providing for interest on debentures, debenture stock, and preference shares, they had been able to pay an interim dividend on the ordinary shares of 5 per cent. per annum, and to carry forward to next half-year a balance of £29,397, or £16,306 more than in the same period of 1886. The loss of income which had been forced on them at the Berlin Conference, as he had stated at the last meeting, caused for a time a suspension of their bonus, but as he had just said, they were carrying forward a very considerable sum. Until, however, they had closed the year there was always the uncertainty that what might be a large sum to carry forward might be materially reduced by interruptions to the cables. He hoped that as they improved more or less the quality of the cables they put into the sea they would lessen the repairs. He referred also to the Tangiers cable, which had been very advantageous to the trade of Morocco, and had also helped the Company materially. With regard to their wire through France, they had not yet obtained permission from the French Government to extend the time for it; but they had made themselves thoroughly independent by laying a fresh cable from Porthcurnow to Lisbon, Gibraltar, Malta, and Zante. That cable was working most satisfactorily, aiding them in carrying their traffic and placing them in a perfectly independent position if war broke out on the Continent to-morrow. Their system was almost entirely duplicated. Had they depended on one wire, with the interruptions that constantly took place it would have been most unsatisfactory in every sense, as it would have interfered with the dividends and with the telegraphing public, and it would have thrown discredit on the whole telegraphic system. They had entirely got the better of that state of things, as he had said, by duplicating, and, in some cases, triplicating their system. He was glad to say that trade was improving with the Colonies. He hoped that all that they had heard about the gold discoveries in Africa would prove correct. The estimation in which this Company was held by the commercial mind of London was shown by the exchange of their 5 per cent. debentures for 4 per cent. stock, showing that a 4 per cent. stock of the Company was considered a sound investment in the city. By means of their reserve fund they had kept down their capital. They had applied the reserve fund in a good many instances to give security to their dividend. If they had kept their reserve fund intact and laid their new cables out of capital they would have added close upon half a million to their capital. Instead of that course, however, which was open to many objections, they had drawn from the reserve fund from time to time and from their current income, and had partly carried out the duplication and triplication of their system in that way. He thought he might congratulate them on the prosperous condition of the Company at the present moment—prosperous because it was built on a sound foundation. He concluded by moving "That the report and accounts of the Directors to the 30th September, 1887, submitted to this meeting be and the same are hereby received and adopted."

The Vice-Chairman (the Marquis of Tweeddale) seconded the motion.

Mr. L. Nicholson asked whether there was a prospect of the cable being duplicated to the Philippines? He desired to propose a rider to the motion moved by the Chairman as follows:—"That the shareholders of the Eastern Telegraph Company tender to Sir John Pender, K.C.M.G., their cordial congratulations on the recent honours conferred on him by Her Majesty as some recognition of his services to Imperial and Colonial interests." He was convinced that the rider would meet with the warm approval of every gentleman present [cheers]. He referred to the many services which the Chairman had rendered to the world in connection with telegraphy, which had done so much to bring the mother country into communication with her Colonies, and, in fact, the whole of the world.

Dr. Waller seconded the rider, which was carried with enthusiasm.

The motion with this addition was then agreed to unanimously.

The Chairman cordially acknowledged the kind remarks of the share-

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holders, and assured them that he very highly appreciated what had been said. Submarine telegraphy was his hobby, and it would probably be so during the whole of his lifetime, and he would use his utmost endeavours to promote the welfare of the Company and the interests of the shareholders. In reply to the question by Mr. Nicholson he said that the Eastern Extension Company, of which he was also Chairman, was now in negotiation with the Spanish Government on the matter.

The retiring Directors, Sir John Pender and the Marquis of Tweeddale, were unanimously re-elected, as were also the auditors.

Mr. JOHN NEWTON then proposed a vote of thanks to the Chairman, and said he desired cordially to acquiesce in the congratulatory remarks which had been made. He pointed out that telegraphy had done more than anything else to promote and make federation possible. It was remarkable that telegraphy was not represented in the House of Lords by anyone who sat there in virtue of his connection with the cable system connecting all parts of the world with this country. He hoped the present recognition of Sir John Pender's services was merely an instalment of higher honours to follow.

The motion having been seconded was carried unanimously.

The CHAIRMAN, in reply, said that the resolution was peculiarly gratifying to him and the Directors, because no man watched more closely or critically the working of the Company than Mr. Newton.

The proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Jan. 18.		Business Done Week Ending Jan. 18. Highest.	Lowest.
Anglo-American	37½,	38½	37⅞	37⅝
Do. Preferred	62,	63	63½	62¾
Do. Deferred	13½,	14½	13⅝	—
Brazilian Submarine	12,	12½	12 3-16	12
Cuba	12½,	13	12¾	—
Do. Preference	18,	19	19	18 9-16
Direct Spanish	3¾,	4½	—	—
Do. Preference	8½,	9½	—	—
Direct United States Cable	8¾,	9 xd	9¼	8 15-16
Eastern Telegraph	11¼,	11½ xd	11 7-16	11 3-16
Do. 6 per Cent. Preference	14¼,	14¾ xd	—	—
Do. 5 per Cent. Debentures, 1899	108,	111	—	—
Eastern Extension	12¼,	12½ xd	12⅝	12 3-16
German Union	9,	9½ xd	—	—
Globe Telegraph and Trust	5¼,	5¾	5⅝	5⅛
Do. Preference	13¼,	13¾	13 9-16	13 5-16
Great Northern	13½,	14	13⅞	13⅝
Indo-European	38,	40	39	38
London Platino Brazilian	4¾,	5½	5 1-16	4¾
Reuter's	7¾,	8½	7¾	—
Submarine	140,	150	—	—
West Coast of America	5	5½	5¼	5 3-16
Do. Debentures	110	115	—	—
West India and Panama	¾,	1	—	—
Do. 1st Preference	9½,	10	9¾	9 9-16
Western Brazilian	9,	9½	9⅜	8⅞
Western Union 7 per Cent. 1st Mortgage	120,	125	—	—
Do. 6 per Cent. Sterling Bonds	101,	104	102¾	—

TELEPHONES.

Consolid. Telephone and Maintenance	9-16,	11-16	⅝	—
Oriental	¼,	⅜	—	—
United Telephone	11¾,	12¼	12⅜	11 13-16
United River Plate Telephone	4½,	5	5	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	2¾,	3¼	3	—
Do. (fully paid)	3¾,	4¼	4 1-16	3¾
Swan	1⅜,	1⅝	1⅜	1 5-16
Maxim Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	38,	39	39	38½
India Rubber, Gutta Percha and Telegraph Works	22,	23	22½	22¼

THE ELECTRO-HARMONIC SOCIETY.

SMOKING CONCERT.

FRIDAY, JANUARY 27TH, 1888.

At the ST. JAMES'S HALL RESTAURANT (BANQUET ROOM), at EIGHT o'clock.

ARTISTES—Mr. Walter Coward, Mr. Arthur Thompson, Mr. James Kift, Mr. Musgrove Tufnail.

SOLO VIOLONCELLO—Mr. W. C. Hann.

SOLO PIANOFORTE AND ACCOMPANIST—Mr. Alfred Izard.

MUSICAL DIRECTORS—Mr. T. E. Gatehouse and Mr. Arthur Thompson.

PART I.

Madrigal—"Down in a Flow'ry Vale" (Festa).
Old English Song—"Once I Loved a Maiden Fair" (temp. James I.), Mr. Arthur Thompson.
Solo Violoncello—"Caprice Hongroise" (Dunkler), Mr. W. C. Hann.
Song—"The Toreador's Song, from Carmen" (Bizet), Mr. Musgrove Tufnail.
Song—"Phyllis is my Only Joy" (Hobbs), Mr. Walter Coward.
Solo Pianoforte—Mr. Alfred Izard. Humorous Song—Mr. Kift.

PART II.

Part Song—"Forget me not" (Abt).
Solo Violoncello—"Czardas" (Fischer), Mr. W. C. Hann.
Ballad—"Oft in the Stilly Night" (Moore), Mr. Arthur Thompson.
Scena—"Travellers All" (Balfe), Mr. Musgrove Tufnail.
Song—"I'll Sing the Songs of Araby" (Clay), Mr. Walter Coward.
Humorous Song—Mr. Kift. Part Song—"Good Night, Beloved" (Hatton).

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 506.—Vol. XX. FRIDAY, JANUARY 27, 1888. Price 4d.

NOTES.

No one will be surprised at the announcement made by the Chairman of the Direct United States Cable Company at its general meeting last Friday with reference to the languid growth of traffic under the sixpence-a-word rate between this country and America. That rate has now prevailed for nearly two years, and has certainly had as fair a trial as it can have with several superfluous cables competing for the business. Whether it would pay if the cables did not exceed the requirements of the traffic is a question now hardly worth discussing. The interesting and instructive fact which this experiment has demonstrated is that the first rush of business under a greatly reduced tariff very soon ceases to grow. Its progress at first promises to pay in the long-run, but the advance it makes soon becomes less and less, with the inevitable result that the longer it runs the less profitable it becomes, the expenses augmenting faster than the receipts. A speedy return by all the Atlantic Companies to a shilling rate—which would be neither unpopular nor unprofitable—is greatly to be desired.

Last week we expressed some degree of scepticism in this column as to the alleged cases of "sunstroke" caused by the electric furnaces at the Creuzot Works, on the ground that such an effect, if possible, would most likely have been heard of before now. We have since learned on unimpeachable authority that the unpleasant phenomena of facial discoloration, and a shredding of the epidermis, as a result of exposure to the electric arc, has not been unknown in this country. We are glad of the opportunity of extending our knowledge of electro-pathology—if that is a correct expression—but we most sincerely regret that the editor of a valued contemporary should himself have been a victim of so unpleasant an accident. Fortunately, however, the effects are merely of a temporary character.

Three years ago last May Her Majesty's Letters Patent were granted for an "invention" of a surprisingly novel and ingenious character. The specification contains only one claim, which reads as follows, "Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is combining with an article of furniture a primary battery or secondary battery substantially as described." Our reason for giving prominence to this remarkable invention arises from the fact that a circular letter has come into our hands, from which it appears that the inventor has reason to believe that certain person or persons (unnamed) have defrauded him of his just rights, and have made and sold articles of furniture combined with primary or secondary batteries substantially as described without having obtained from him, the aforesaid first and true inventor thereof, a licence so to do. We trust that the publicity which we now give to these proceedings will be sufficient to deter such persons from further carrying on malpractices of so palpable and reprehensible a character. We may add that merely in order to satisfy our own curiosity we should be interested to hear from any of our readers who may happen to have seen such a combination in use prior to the fifth day of May, 1884.

Amongst those who are working at the heat conversion problem in America, some attention has lately been given to a device by Mr. Acheson (of Pittsburg), who has designed an apparatus, which he terms a "cal electric generator." No numerical details of the results obtained have yet been published, and it remains to be seen whether the method adopted is capable of leading to results of practical importance, or whether, indeed, the whole idea is not based upon a mistaken induction. Our readers will, however, be able to form their own views on this point, and we do not wish at present to express a decided opinion. Mr. Acheson's apparatus may be described as a hollow cylinder of iron, through which two coils of wire are threaded. One coil is of fine wire, and is wound closely upon the iron; the second, which is of stouter wire, passes loosely through the centre of the cylinder and extends for some distance beyond. It will be seen that this is nothing more than a transformer with a wide and loose secondary coil. It is not, therefore, surprising to learn that when an intermittent current is passed through the primary coil a current is generated in the secondary. So far, all is plain sailing; but Mr. Acheson now takes the loose exterior wires of the secondary coil, and places them over a row of gas jets, so as to establish a "flow of heat" in the wire. It might have been supposed that the chief effect of this procedure would have been the increase of resistance of the secondary circuit by the rise of temperature; but we are told that, as a matter of fact, the result is to produce a conversion of heat into electrical energy, on a scale sufficiently marked, we presume, to justify the title of "cal-electric generator."

It must be admitted that there is enough in this description to justify some degree of scepticism as to whether the appa-

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ratus does really effect the conversion of heat, or whether the E.M.F. is not wholly due to ordinary induction. But it is difficult to suppose that Mr. ACHESON can have committed so glaring a mistake as this would involve. And, indeed, from a later communication to the *Electrical World* we learn the fundamental idea which he has had in view. He says: "While I believe that it is to the first publisher of a discovery that the honour belongs, and without any desire to detract from the honour due to MM. HINGHAUSEN and NERUST, I wish, in justice to myself and as a means of establishing the links of the chain, to state that in the month of July, 1886, I made similar experiments to theirs and with like results. It may be that they did their work prior to this date, although the first notice I find of it is in the London *Electrician* of Feb. 18th, 1887."

IN case any of our readers should have overlooked this experiment (which is of considerable theoretical interest) we may here repeat in brief the description which will be found at greater length in our issue noted above. MM. HINGHAUSEN and NERUST placed a thin strip of metal in a magnetic field in which the lines of force passed at right angles to the plane of the strip. They then caused a flow of heat to pass longitudinally through the metal—in other words, they heated one end and cooled the other. Under these circumstances, when two points at opposite sides of the strip (breadthwise) were connected to a galvanometer it was found that a difference of potential existed between them, and a continuous current could be taken off so long as the flow of heat continued. That this was not a thermo-electric effect was proved by the fact that the direction of the E.M.F. was reversed by reversing the magnetic field. The difference of potential was, however, very small, and comparable to that of the "HALL effect," which, indeed, suggested the experiment in question, and which it closely resembles. In fact, it seems to us that the HINGHAUSEN-NERUST effect would almost certainly be entirely swamped in Mr. ACHESON'S experiment by the ordinary induction—if we rightly understand the conditions.

ONE further remark obviously follows. If Mr. ACHESON has succeeded in converting heat into electrical energy by a development of the HINGHAUSEN-NERUST experiment he ought not to require an *intermittent* current in the primary. The beauty of this method would consist—if it could be shown to be of any use on a practical scale—in the fact that no mechanical or electrical reaction is involved, the only source of dissipation of energy in the conversion being that due to the radiation of heat in the maintenance of two widely different temperatures in the same mass of metal. We confess that the possibility of an industrial application of the principle does not to us appear a very hopeful one, but the idea is perhaps worth following up.

IT is certainly peculiar to find a maker of series lamps introducing them to the public and at the same time pointing out *quite* so many disadvantages to their use, as is done in Mr. W. SIEMENS' paper, which we print elsewhere. To two of his points we must take some exception. First, it is not fair to take an unflashed Edison bamboo filament as a standard with which to compare his own carbon, for such filaments are not used in practical work; secondly, we doubt very much whether, while strongly attacking the Bernstein system, the author is justified in saying that the saving in leads due to series running is more than counterbalanced by the cost of cut-outs to each lamp. This comparison is made on the basis of his own cut-out, which, it seems, cost thirty shillings; whereas in the system he attacks a far simpler and neater device is used which probably does not cost thirty pence, or even farthings.

IN another column will be found the twelfth annual report of the Telegraphists' School of Science, which is conducted by Mr. W. SLINGO at the Central Telegraph Office, in connection both with the Science and Art Department and the City and Guilds of London Technical Institute. This interesting school was commenced by Mr. SLINGO—at that time a telegraph clerk in the Central Office—in September, 1876, with the object of inducing his fellow clerks to take an intelligent interest in their work and to become qualified for the technical staff. The subjects taught are mathematics, chemistry, magnetism and electricity, and technical telegraphy, and provision is made both for laboratory and workshop instruction and practice. The school has had a most successful career, and this year, in the proportion of prizes awarded, it stands at the head of the list for the entire kingdom. Although both teachers and students have had, hitherto, to give their own time to the lessons, yet, as might have been anticipated, the Department has been very willing to grant facilities for the work, and several years ago two large rooms were placed at Mr. SLINGO'S disposal. The long list of "local prizes" shows that the superior officers of the Department have, moreover, adopted a very practical form of proving their interest in the undertaking. We understand that there is now considerable probability that the school will obtain further official recognition, and we hope soon to hear that Mr. SLINGO will be enabled to devote his whole time to the work.

ALTHOUGH newspaper articles on scientific subjects are seldom instructive and often misleading, we notice with satisfaction the increasing amount of attention lately given to electric industry by the daily press. The fact seems to indicate, as one of these journals puts it, that "electric lighting is an industry which is about to spread its wings." On the same authority, however, we learn with some surprise that safety fuses are a quite recent invention, and that all or nearly all the electric-lighting plant used in this country is imported from abroad. If this were the case, we should expect the industry to soon take flight altogether.

WE learn with some surprise and not a little disgust that the project for inflicting capital punishment by electricity, broached five or six years ago, and condemned by us at the time, has again cropped up—this time in the State of New York. A commission we are told has pronounced its award in favour of the electrical method; and we have no choice but to accept the statement. But when it is added that "various

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plans for applying the electric current have been proposed by rival engineers," we take leave to doubt it. That electrical engineers may be hard pressed for business, even in New York, is conceivable; but that they have entered into competition with Jack Ketch and Judge Lynch, we refuse to believe. If society has grown too squeamish to avenge itself on its enemies in the old-fashioned way, science, we feel confident, will decline to do the dirty work for it. We protest especially against associating electricity with this revolting business. What would be said of us if we suggested poisoning the culprit with gas? Mr. EDISON, we are pleased to notice since writing the foregoing, has expressed his detestation of the whole affair.

"FOUR MINUTES instead of four months, that is the measure of the shrinkage of this plastic world beneath the magic touch of the electrical engineer!" Such is the moral which the *Pall Mall Gazette* has drawn from "the most extraordinary interview on record." We should have thought that the expansion of the world, not its shrinkage, would be the idea suggested by such interviews as these. But, be that as it may, they are by no means uncommon, though not often "on record;" and the only extraordinary thing about the one described is the nonsense which the interviewers talked to each other. When telegraphists are put through to long distances—often on longer stretches than any that were spanned by the *P. M. G.* last Sunday evening—they have always something to say; on this occasion, these eminent journalists and sabbath-breakers had nothing to say, and said it at great length. Some people will, we suppose, believe, as the *P. M. G.* evidently intends they should, that "the political revolution thus effected" by a telegraph line 7,000 miles in length is the invention of that enterprising journal, just as they appear to believe that it is the author of the Seventh Commandment. Our own hope and trust is that the real authors of the telegraph lines will make the *P. M. G.* realise the shrinkage of its plastic purse for this three hours' fooling. For if the companies do not profit by it nobody else will—not even the editor of the *P. M. G.*, whose admirers, as a rule, hold the Fourth Commandment in some estimation, and will not approve of its being needlessly broken for journalistic speculations of this unedifying kind.

Copper.—A further decline has taken place in the price of copper, Chili bars being yesterday quoted £73. 17s. 6d. to £74. 7s. 6d.

The Brussels-Paris Telephone Lines.—The second telephone line between Paris and Brussels has just been completed, and will shortly be opened for traffic. This line passes through Soissons, Laon, Vervins, and Herson.

The Lighting Messrs. W. H. Smith and Son's Premises.—We are informed that Messrs. Woodhouse and Rawson have been entrusted with the wiring of the extensive premises of Messrs. W. H. Smith and Son in the Strand, in connection with an installation of the electric light.

Utilisation of Water Power at Basle.—A new canal tapping the waters of the Rhine has just been completed at Basle, and the municipal authorities are anxious to utilise a portion of the fall for lighting the town. No scheme has yet been prepared, and they are open to receive suggestions.

Electrical Watches.—A German paper announces that a company has been formed (apparently in Berlin) for the manufacture of watches to be actuated by electricity. The case contains two small cells and a small electric motor actuated by a make-and-break movement. Watches of this type have already been made, but have never hitherto been regarded as anything more than curiosities.

The Export of Telegraph Wire.—The value of telegraph wire exported during the year 1887 was £817,497, against £992,667 for the year 1886, showing a decline in the twelve months of £175,170. The exports for the month of December show an increase of £87,932 over the corresponding month last year, the export for December, 1887, amounting to £114,869.

Telegraphic Communication with Lightships.—The Board of Trade has informed the Dover Town Council that experiments are to be made, over a period of eighteen months, with an electric cable between one of the Goodwin Sands lightships and the shore. If the experiments are found to be successful, other cables will be laid between the shore and lightships in dangerous positions.

Temporary Installation at Tranby Croft.—On the occasion of a ball given last week at the residence of Mr. Arthur Wilson at Tranby Croft in honour of H.R.H. Prince Albert Victor, a temporary installation of electric light was carried out by Mr. Thomas Muse, of Hull. This is the sixth year in succession that Mr. Wilson's residence has been lighted for similar purposes by the same firm.

The Chinese Telephone Concessions.—The American journals express the fear that the death of the father of the Emperor of China will lead to the revocation of the telephone concessions recently accorded to an American syndicate. The deceased prince was at the head of the Liberal and progressive party in China, and his death will probably result in a change in the policy of the Government, which may put an end to all foreign enterprise.

Curious Experiment on Foucault Currents.—*La Nature*, in a recent number, describes a curious experiment illustrating the effect of Foucault currents. A disc of soft iron has a spindle put through it so that it can be spun like a top. When at rest or moving slowly the disc is of course attracted by the poles of a magnet. But when it turns with sufficient velocity it is repelled by the magnet. In this case the electro-magnetic reaction of the currents induced in the mass of the metal is greater than the magnetic attraction.

Researches on the Commencement of Visible Radiation.—H. F. Weber finds that a 16 candle-power, 100-volt, 0·5-ampere Siemens glow lamp is just visible in a perfectly dark room at 13·07 volts and 0·051 ampere, the filament appearing a dusky grey, which with increase of current becomes ashy grey and then yellowish grey. At 18 volts and 0·06 amperes the first trace of red appeared. The temperature of the first "grey-glow" was found for platinum to be 390deg., for gold 417deg., and sheet-iron (not freed from oxide) 377deg. The temperatures were determined by a thermo-electric couple.

The Lighting of the City of London.—At the meeting of the City Commissioners of Sewers, held on Tuesday last, Mr. J. S. Bell brought up the report of the Streets Committee, which contained an amended agreement with the Anglo-American Brush Electric Light Corporation, the latter having now agreed to the insertion of a clause requiring the deposit of caution money before commencing the work. Very few members being in attendance at the time, it was agreed that the report should

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be printed and circulated amongst them, and should be considered at an early hour at the next meeting of the Court. Some of the daily papers have stated that the company agreed to abandon their claim for a monopoly of the public supply of current in the district to be lighted. This statement is, however, inaccurate.

Conversazione of the Employes of the Edison and Swan Company.—A *conversazione* and concert of a very interesting character was held at the Edison and Swan Company's Works, Ponder's End, on Tuesday evening, 17th inst. Nearly the whole of the *employés* accepted the invitation of the manager, Mr. Gimingham, to whose kindness the entertainment was due. An excellent programme was provided, to which the more musical section of the *employés* largely contributed. The accompaniments were played by Mrs. Gimingham and one or two of the young ladies in the factory. The rooms were draped with flags, and the light from coloured incandescent lamps, which were hung about the room, made the decorations look very effective. Light refreshments were provided in an adjoining room. The arrangements were carried out under the direction of the works foreman, Mr. Robson.

Note on the Reading of Dial Instruments.—In order to obviate the effect of parallax in taking readings from a needle moving over the face of a dial, instruments are frequently provided with a mirror underneath the needle, so that when the image of the needle is hidden from the eye by the needle itself we know that the true reading may be obtained. In a note to *La Lumière Electrique*, M. F. Drouin points out, however, that even when no mirror is provided it is easy to take an accurate reading provided that the dial be enclosed by a cover of plane glass parallel to the needle. If a small parallelopipedon of flint glass (or any substance having a different refractive index from that of ordinary glass) be placed over the needle against the outer face of the glass cover, so long as any parallax exists the needle will appear broken—that is, the part seen through the parallelopipedon will appear displaced from the straight line. When the needle is viewed perpendicularly over the dial this effect disappears.

The Telephone at the Brussels International Exhibition.—The Administrative Council of the Brussels Exhibition has determined to make a great feature of the display of telephonic apparatus. A large number of telephone call stations will be erected in the Exhibition and all the restaurants, places of entertainment, &c., will be connected to a central telephone exchange within the building, which will be open to public inspection. It is hoped that there will be here represented all the different arrangements now employed by the telephone companies, and especially the latest improvements in switchboards. It is also intended to connect the Exhibition with the Brussels Exchange, from which, as our readers are aware, trunk wires radiate to many towns in Belgium, and it will therefore be possible for visitors to the Exhibition to speak from any call office to their friends in many parts of the country, and even as far as Paris. The Council invites participation of all telephone companies, and communications should be addressed to MM. Mourlon and Bandsept, 22, Rue des Palais, Brussels.

"The Diseases of Dynamos."—"W. H." writes to the *Electrical World*, of New York, as follows:—I have read with much interest in the *Electrical World* of Dec. 17th the article on "The Diseases of Dynamos," by Silvanus P. Thompson, in which is mentioned a small dynamo that gave trouble at the brush rocker. At one time the writer had some trouble with the insulation under the brush clamp and rocker of a Brush dynamo which caused short-circuiting. Although nothing serious came of it, it was, nevertheless, very annoying. I believe the insulation was of fibre. For a remedy, we tried several kinds of insulation, such as mica and asbestos, but they did not last. I think the trouble was largely due to copper dust from the commutator falling on the insulation and thus making cross connection. Finally, some two years ago, we tried an insulation of slate a little larger than the brush clamp, and since then have had no trouble. I think the good results are due from the slate being waterproof and smooth on its edges. I have mentioned this, as it may be of interest to some of the readers of the *Electrical World*, who have had similar trouble with insulation in wet or dusty places.

The Volta Prize.—The Commission appointed by the French Government to award the Volta prize of 50,000fr. for the most important application of electricity has recommended that it should be awarded to M. Gramme. It is not probable that anyone in this country would be disposed to challenge this decision. A choice of this kind necessarily entails more or less invidious comparisons, but in this case no one would for a moment suggest that M. Gramme's services in advancing the practical application of electricity are not entirely adequate to such a distinction. In France, however, the award has failed to give complete satisfaction. The *Paris* enters a vigorous protest against the decision of the Commissioners, and champions the claims of M. Gaulard, as the inventor of the transformer. It is undeniable that M. Gaulard was instrumental in forcing the transformer upon the attention of the scientific world, and for this he unquestionably deserves thanks and praise. But there are very few electricians, in this country at least, who would opine that M. Gaulard's achievements rank with those of M. Gramme; and this at least is not the view of the commissioners of the Volta prize.

Walker's Portable Miners' Electric Lamp.—This lamp is at present made in two forms, one of round and the other of oval section. The round form contains two cells of a zinc carbon bichromate battery in the oval pattern. There are three such cells. The carbon of the battery itself forms the containing vessel. Externally on one side of the case is a lens faced by a parabolic reflector, the two being held by a strong brass cylinder attached to the outer case, which is also of brass or copper. The cells contain the usual porous pots and zincs, and are closed by an india-rubber pad, above which the connections are made in a simple and efficient manner. A second pad of india rubber is placed above this, and is retained in its place by the cover, which is held by screws or a lock, as desired. A stout handle surmounts the whole. The smaller lamp is made of cylindrical form, weighs 5lb., and gives a light for ten hours sufficient to read ordinary newspaper print at 6ft. from the lamp. The cost of renewing the chemicals, the incandescent lamp, and incidental repairs, is stated to be not more than ¾d. per day for the small lamp, and 1d. per day for the larger type. We are glad to learn that the introduction of electric light is making rapid progress in the South Wales colliery district.

Royal Meteorological Society.—The monthly meeting of this society was held last week at the Institution of Civil Engineers, Mr. W. Ellis, president, in the chair. The paper read was on "The Non-Instrumental Meteorology of England, Wales, and Ireland," by Mr G. M. Whipple. Mr. Ellis, in his presidential address, reviewed briefly the work and position of the society, remarking that such a society, whilst unable to carry out expensive, original, or experimental work, could yet act with great advantage in inciting volunteer workers throughout the country to united action, of which one recent example was the

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ready response to the request of the society for photographs of lightning, an excellent collection of which had been attained, and would shortly be exhibited. Referring to the question of sympathetic relation between sun-spots and magnetism and meteorology, he thought that any complete treatment of the question in its meteorological aspect seemed to require that it should be dealt with in a much more comprehensive manner than before, for which purpose observations more completely covering the surface of the globe might be necessary, if indeed not necessary also for the solution of many other meteorological questions, the present meteorological stations being distributed over the earth in such isolated clusters.

The Heeling Error of the Compass in Ships.—At a recent meeting of the Philosophical Society of Glasgow Mr. Wm. Bottomley read a paper on "The Heeling Error of the Compass in Ships." He did not propose to enter into the general question of the magnetism of an iron ship and the errors of the compass which it produced, but would confine himself to the consideration of the disturbance which was experienced when the vessel heeled over. He would assume that with the ship on an even keel the effect of the magnetism of the ship's iron on the compass had been compensated by Airy's well-known plan of placing magnets fore and aft and thwartship to correct the semicircular error and masses of soft iron on each side of the compass for correcting the quadrantal error, and that the compass was correct on all courses when the ship was on an even keel. When the ship heeled over the altered position of the iron of the ship produced a change in its effect of the compass and gave rise to the heeling error. The disturbance due to heeling arose from two separate causes—first, the component of the ship's permanent magnetism which is perpendicular to the deck; and, second, the magnetism induced in the soft iron of the ship by the vertical component of the earth's magnetism. It was with the error produced by the second of these causes the lecturer dealt. That was by the magnetism induced in the soft iron of the ship by the earth's magnetic force, and he also showed that the masses of soft iron which were placed on each side of the compass to correct the quadrantal error when the ship was upright exercised a most important part in correcting the heeling error when the ship heeled over if they were fixed to the binnacle and moved with the ship.

The Thomson-Houston System in Brussels.—Lighting of the Moliere Theatre.—Our Brussels correspondent writes :—"A branch of the Thomson-Houston International Electric Company has been formed in Brussels under the title of the Belgian Thomson-Houston Electric Company, of which M. A. Admirallie is manager, and partly with Belgian and partly with American capital. A central station has been established in the Chaussée de Wavre, near the Porte de Namur, for lighting by contract at the same rate per candle-power that gas is now charged. Operations were begun definitely on 15th January, the lessee of the Molière Theatre, which is now lighted entirely by electricity, being the first and principal subscriber. The installation of the central station includes a forty indicated horse-power horizontal engine by Mennig Frères, of Cureghem-Bruxelles, the steam distribution of which is effected in a very simple yet effective manner, giving great regularity. A horizontal shaft, parallel with the centre line of the engine, carries two-edge cams for opening the steam valves, which are closed by other cams and levers assisted by springs, while a face cam opens the exhaust valves. The shaft is shifted laterally by a lever actuated directly by the governor for giving greater or less admission of steam. There are at present two dynamos, capable of maintaining, one thirty 1,200-candle arc lights, and the other 250 small incandescent lamps. The Molière installation includes two 1,200-arc lamps, one outside the theatre and one in the middle of the central chandelier, a 65-candle and five 32-candle incandescents, all in one circuit, and also a separate circuit for the stage, with about 200 incandescents of 10 and 16 candles, for the footlights, borders, and battens. By thus running the lamps in separate circuits, if a fire should break out on the stage, and the iron curtain descend, as it would, automatically, the lamps in the front of the house would be unaffected. Nine different degrees of brilliancy can be given to the lamps, thus leaving nothing to be desired as regards stage effect. By means of the Thomson-Houston regulator any lamp can be switched off without affecting the others, even momentarily, nor is there any need of introducing resistance coils. M. Alhaiza, the manager of the theatre, expresses himself perfectly satisfied with the lighting, both arc and incandescent lamps being absolutely constant."

Electric Lamps in the Welsh Collieries.—The following letter, written by a gentleman whose knowledge of mining affairs is described as authoritative, appeared recently in the *Evening Citizen*, of Glasgow:—"I have waited for another opportunity of seeing the electric lighting before replying to your letter, as I wanted to be able to give accurate information. I saw 200 lamps at work, and I formed a very favourable impression as to the success of the system. Indeed, I see nothing to prevent their general adoption, and I am satisfied that the men like them. The weight is 7lbs., but that does not appear to be an obstacle, although it would doubtless add to their value if a good enough light could be had by a lamp of less weight, say 4lb., about the weight of an improved safety lamp. You see the men at the face have only to carry them in and out, and they do not object to carrying 7lb. in a handy shape. The light is equal to 8 or 10 Clanny lamps at the start, it gets less towards the end of the shift, but at the end of 10 hours is still better than a Clanny. The men like them. As to the cost, I believe they will not cost more than £1, but this is only a guess. The time is too short to tell what the cost of upkeep will be, but, judging from electric lighting on the surface, the cost will not be heavy, and will probably be *much less* than that of ordinary safety lamps. The chief item of cost will be the renewal of the glow lamp, and as these are much smaller than the ordinary glow lamps, their cost will not be much, perhaps 2s. 6d. The lamp burns at its full capacity from the beginning, the idea of reserving so much force and manipulating the light after a few hours having been abandoned. The aim is to have a good enough light at the end of, say, ten hours. A defect at present, but one which is to be remedied, is that as soon as the lamp is put together it must burn, and so in the giving out of lamps a large number may be burning an hour before they are actually needed. The arrangement of charging is simple in the extreme—a boy can manage several hundreds. They are placed in series on tables, 60 in a block, and remain seven or eight hours. An index lamp burning in front of each row of eight shows when the lamps in that row are charged by its light getting dim, the current *skipping* the row then, and, of course, not going through the index lamp with the full strength of current. The battery portion of the lamps are exactly the same, and fit any one of the square receptacles on the table. After the lamps have been a few days in use (it takes a few days to get them into trim, to get *saturated*, as it were, or into the proper condition to absorb the electricity), they burn well for ten hours, and no one now need be afraid to go in for them."

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EARLY RESEARCHES IN THERMOMAGNETIC GENERATORS.

(Concluded from page 258.)

At the Loan Exhibition of Scientific Apparatus, held at South Kensington in 1874, Dr. G. Gore exhibited an apparatus which is illustrated in the adjoining figure, and which appears as No. 1,136 in the third edition of the Catalogue under the title "Apparatus for Showing a Series of Molecular and Magnetic Changes in an Iron Bar."

In the figure A is a horizontal bar of iron fixed to the apparatus securely at its left-hand extremity; B a coil of thick copper insulated wire surrounding the bar and connected with a battery; C a coil of thin copper insulated wire, also surrounding the bar, with its ends attached to a distant galvanometer; D a removable lever, weighted at its free end, for exerting compression by means of a transverse iron axle and clutch, F, upon the iron bar lengthwise. By reversing the position of this lever to that of the horizontal dotted lines, it exerts traction upon the iron bar; E another removable weighted lever, fixed upon the free end of the iron bar, which in the position given exerts right-handed torsion upon the bar, but if transferred to that shown by the dotted lines, exerts left-handed torsion. The levers may be used either singly or combined. If the bar be heated to redness at its middle part to a temperature above that at which it suddenly loses a large portion of its magnetic capacity, the influence of mechanical compression, extension, and torsion, either singly or combined, upon the peculiar molecular changes, can be examined. Screens are placed between the flames and the coils to protect

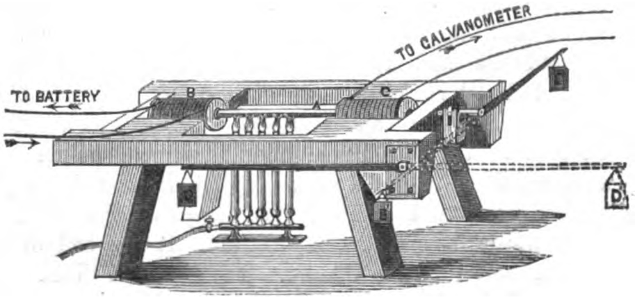

Fig. 2.

the latter from the heat, and sometimes pieces of firebrick are placed on each side of the heated part of the bar to concentrate the heat, as in an ordinary tube combustion furnace.

The proposed experiments on the effects of strain and torsion were never carried out by Dr. Gore, but he made a careful examination of the thermo-magnetic properties of iron and nickel, and the conclusions arrived at will be found in the *Phil. Mag.*, Vol. XL., 1870, p. 175. It will be found that these conclusions are quite in harmony with the later and more complete results which we published last week, and the investigation, though to some extent superseded by these later researches, has yet a good deal of interest of its own. The following is the portion of the paper which refers to nickel, and is therefore the most interesting at the present time:—

"With a bar of cast nickel about 18in. (=45·7 centims.) long and ½in. (=12·7 millims.) thick, the following effects were obtained:—During heating a slow deflection of 1¼deg. was obtained at a particular temperature much below a red heat; and during cooling a deflection of 1½deg. in an opposite direction occurred, apparently at the same temperature; no other deflections were obtained by heating the bar gradually to redness and then cooling. With another bar of that metal, 2ft. long and ¾in. in diameter, a thick wire coil 6in. long and 2¼in. (=5·7 centims.) in diameter, containing eight layers, or 536 turns of 'No. 17' copper wire, and a thin wire coil 6in. long and 2in. in diameter, containing 14 layers or 1,960 turns of 'No. 27' copper wire, on applying the full heat of five small Bunsen's burners, in about four minutes the needles were rather suddenly deflected 2¼deg., with irregular action at a particular temperature, not even approaching that of the lowest visible redness in the dark; and by heating to a much higher temperature, but still below redness, faint signs of a second similar molecular disturbance in the same direction were manifested. The heat being now stopped, and the bar allowed to cool gradually, the same phenomena, and to the same extent, took place, but in an exactly reverse order. On repeating the experiment with this bar, but cooling the bar rapidly by continuous application of cold water, a sudden deflection of 8deg. occurred when the bar acquired the proper temperature. The direction of all the deflections with this bar (as with nearly all the previous bars) during heating agreed with those producible by a *decrease* of magnetism, and during *cooling* with an *increase* of magnetism. By substituting for the fine-wire coil another, containing 3,600 turns of size 'No. 29' (=0·28 millim. thick) copper wire, very feeble results only were obtained, the coil itself offering too great a degree of conduction-resistance.

"In these experiments with wrought iron, steel, cast iron, and nickel there is a very *gradual* magnetic change, in addition to the several sudden or irregular molecular movements and changes of magnetism; this gradual change is manifested by a very faint deflection of the needles in the same direction as those produced by most of the sudden movements."

In another paper in the *Phil. Mag.*, Vol. XL., 1870, "On the Magnetism of Electro-Dynamic Spirals," Dr. Gore describes some experiments of a simple and easily repeated form which are admirably adapted for the lecture table. Figs. 3 and 4

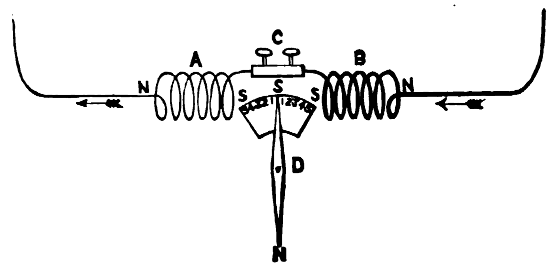

Fig. 3.

illustrate these experiments. Two spirals, A and B (Fig. 3), having the same number of turns but of different metals, are connected together at C, and a strong current is passed through them. A compass needle is brought between the spirals, and

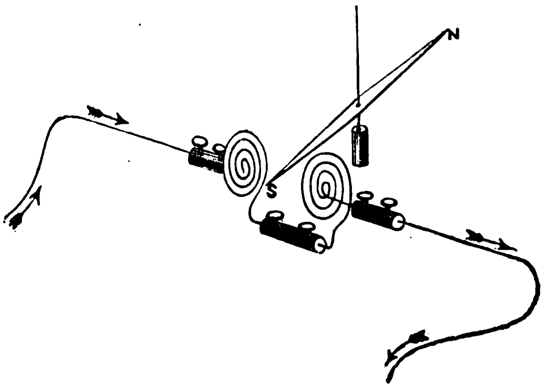

Fig. 4.

the winding is so arranged that the pole of the needle remains in equilibrium, being repelled by each spiral equally. Now with two non-magnetic metals, say, German silver and platinum, the spirals being in series, the current may be increased to any extent, heating the wires to redness, without at all affecting the equality of the action, and the needle remains in equilibrium. But if the same experiment be repeated with one coil of iron, and the other, say, of platinum, the phenomena are of a much more complex character. First, with no current in the coils, the needle is attracted to the iron; but when a small current flows, this attraction is presently overcome by electro-dynamic repulsion, and as the current is increased the power of the iron spiral gradually becomes equal to, and at length exceeds, that of the platinum. This is due to the fact that while the electro-dynamic (or solenoidal) action of the two spirals remains the same, the iron possesses also a molecular magnetisation of its own which is induced by the current. Suppose, however,

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that at this stage a balance is restored, which can be done most conveniently by bringing the pole of a magnet to the assistance of the platinum spiral. Then, if we continue to increase the current, in order to maintain the balance, we shall at first have to bring the compensating magnet nearer and nearer. But by-and-bye, as the iron approaches a bright red heat (or, as we now know more exactly, a temperature of 700deg. C.), the iron suddenly begins to lose its molecular magnetisation, until at 780deg. C. the platinum spiral is again able to maintain a balance without the assistance of the magnet, the iron now acting as a non-magnetic metal.

Fig. 4 is only a modification of the same experiment.

NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

(Continued from page 237.)

We require in the next place to find the value of the mean of the square of the ordinates to the same curve, assuming them to be equi-distant and infinite in number. If y_1 y_2, &c., are the ordinates, and n the number, we require to find the value of

$$\frac{1}{n}\left(y_1^2 + y_2^2 + y_3^2 + \&c.\right)$$

as above ; the value of any ordinate being

$$y = A \sin \frac{\pi}{l} x.$$

Hence, if $X X' = l$ is divided into n intervals, each equal to δx, so that $n \delta x = l$, we have to find the value of

$$\frac{A^2}{n}\left(\sin^2 0 + \sin^2 \frac{\pi}{l}\delta x + \sin^2 \frac{\pi}{l} 2\delta x \quad . \quad . \quad . \quad + \sin^2 \frac{\pi}{l}\overline{n-1}\,\delta x\right);$$

but since
$$\sin^2 \theta = \frac{1}{2}\left(1 - \cos 2\theta\right),$$

the series in the bracket can be replaced by

$$-\frac{1}{2}\cos 0 + \frac{1}{2} - \frac{1}{2}\cos\frac{\pi}{l} 2\delta x + \frac{1}{2} - \frac{1}{2}\cos\frac{\pi}{l} 4\delta x + \&c.$$
$$. \quad . \quad . \quad . \quad + \frac{1}{2} - \frac{1}{2}\cos\left(\frac{\pi}{l} 2n\delta x - \frac{\pi}{l} 2\delta x\right)$$

for n terms. Hence the mean value M is

$$M = \frac{A^2}{n}\frac{n}{2} - \frac{A^2}{2n}\left(\cos 0 + \cos\frac{\pi}{l} 2\delta x + \&c.,\right)$$

for n terms.

The cosine series forms a progression of terms which begins with unity, since $\cos 0 = 1$ and passes down through zero to -1, and then up from -1 through zero to unity again,

since
$$\cos\left(\frac{\pi}{l} 2n\delta x - \frac{\pi}{l} 2\delta x\right) = +1,$$

when $n \delta x = l$.

Since the angles are in arithmetic progression we can pick out from this series pairs of cosine terms, such that they are equal in magnitude but opposite in sign, and hence, taken pair and pair, they cancel each other out, and leave the sum of the cosine series in the bracket equal to zero, and hence

$$M = \frac{A^2}{2},$$

that is the mean of the values of all the ordinates squared taken equi-distant and infinite in number is half the square of the maximum value.

We have, therefore, this result. If the current in a linear conductor varies in strength and direction in a manner which geometrically would be represented by the ordinate of a simple sine curve, then the true mean value of the current strength is $\frac{2}{\pi}$, or ·637 of its maximum value, and the mean value of the square of the current strength taken at equal and very small intervals is half the value of the square of the maximum.

Since $\frac{2}{\pi} = \cdot 637$ and $\frac{1}{\sqrt{2}} = \cdot 707$, and since the difference $= \cdot 07$, the true mean current is less than the square root of the mean of the squares at each instant by an amount which is very nearly 10 per cent. of the latter.

The next geometrical proposition to which we pass is one of some importance.

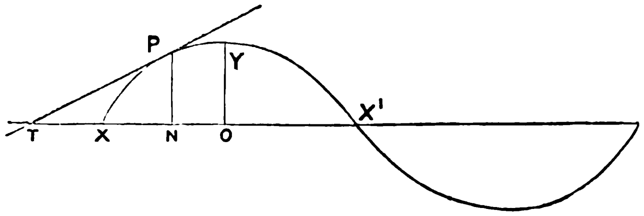

FIG. 14.

Let the curve in Fig. 14 represent the complete period of a simple periodic curve of which the equation is $y = A \sin \frac{\pi}{l} x$. Let P be any point on the curve, then $P N = y$, $O Y = A$, $X X' = l$. At P draw a tangent P T to the curve, and let it meet the datum line at T.

We shall call the trigonometrical tangent of the angle P T N, the *slope* of the tangent at the point P, hence $\frac{P N}{T N}$ = the slope.

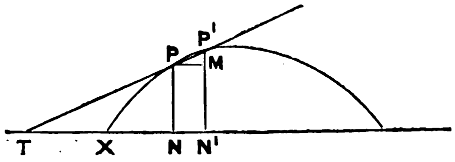

FIG. 15.

If two points, P P' (Fig. 15), are taken on the curve very near together, and a secant, P' P T, drawn through them, this secant will become a tangent when the points P P' move up into contact. The ratio of $\frac{P' M}{P M}$ will then, in the limit, become the slope of the tangent. If, now, $X N = x - \frac{\delta x}{2}$ $X N^1 = x + \frac{\delta x}{2}$, and $P M = N N'$ is δx, we have the equations

$$P N = A \sin\frac{\pi}{l}\left(x - \frac{\delta x}{2}\right)$$

and
$$P' N' = A \sin\frac{\pi}{l}\left(x + \frac{\delta x}{2}\right)$$

and
$$\frac{P' M}{P M} = \frac{A}{\delta x}\left[\sin\frac{\pi}{l}\left(x + \frac{\delta x}{2}\right) - \sin\frac{\pi}{l}\left(x - \frac{\delta x}{2}\right)\right]$$

The quantity in the bracket is identically the same as

$$2\cos\frac{\pi}{l} x \sin\frac{\pi}{l}\frac{\delta x}{2},$$

and hence

$$\frac{P' M}{P M} = \frac{A}{\delta x}\frac{\pi\,\delta x}{l\ 2}\,2\cos\frac{\pi}{l}x\left[\frac{\sin\frac{\pi}{l}\frac{\delta x}{2}}{\frac{\pi}{l}\frac{\delta x}{2}}\right]$$

$$= \frac{A\pi}{l}\sin\left(\frac{\pi}{l}\left(\frac{l}{2} - x\right)\right)\left[\frac{\sin\frac{\pi}{l}\frac{\delta x}{2}}{\frac{\pi}{l}\frac{\delta x}{2}}\right]$$

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When $\delta x = 0$, the quantity in the square brackets is unity, and we have

$$\text{slope} = \frac{A\pi}{l} \sin\left(\frac{\pi}{l}\left(\frac{l}{2} - x\right)\right).$$

If we plot a curve whose ordinates at any point are the slope of the primal curve at the corresponding points, the above equation shows us three things—first, that it is a sine curve or simple periodic curve of the same type as the curve from which it is derived; second, that its maximum value is $\frac{\pi}{l}$ times the maximum value of the original; and third, that its zero ordinate corresponds to the maximum one of the original, and *vice versâ*.

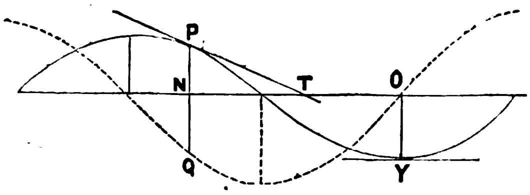

Fig. 16.

In Fig. 16 the firm line curve is a curve of sines

$$y = A \sin \frac{\pi}{l} x,$$

the dotted line is a curve of sines, whose ordinate Q N at any point represents the *slope* of the tangent at P on the original curve. Accordingly at Y, where the original curve is at its maximum, and the slope of its tangent is zero, the derived curve cuts the datum line, or has its phase shifted 90deg. backwards relatively to the original curve. In the language of the differential calculus, the firm line curve is the plotting of $y = A \sin \frac{\pi}{l} x$, and the dotted curve is the plotting of $\frac{dy}{dx}$ as ordinates for the same abscissæ. We may regard it from another point of view. Let the simple sine curve be supposed to be generated, or marked out by a tracing point, P, which moves to and fro along a line P N P′ with a simple harmonic motion, whilst the point N moves uniformly along a straight line X X′. (See Fig. 17.)

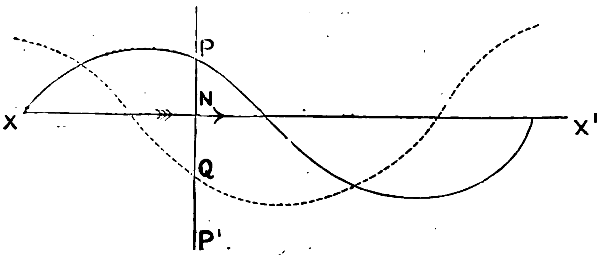

Fig. 17.

Draw as before the dotted curve whose ordinate Q N at any point represents the slope of the firm curve at the corresponding point P. Then the magnitude of N Q will represent the *rate* at which the ordinate P N is increasing or decreasing. For in this case, distances such as X N, measured along the mean line, are proportional to time, and hence N makes a small movement forward in a small time dt; there is a corresponding decrease in the ordinate P N, which we may denote by dy, and accordingly $\frac{dy}{dt}$ represents the rate of decrease of P N. If the small forward movement of N causes N to advance through a space dx, dx is proportional to dt, as the motion is uniform, and accordingly $\frac{dy}{dx}$ is proportional to $\frac{dy}{dt}$, hence $\frac{dy}{dt}$ is at any instant graphically represented by the slope of the tangent at P—that is, by the ordinate P′ N. The dotted curve represents, therefore, the *rate of change* of the ordinates of the firm curve at that same instant. We shall call the dotted curve the *derived curve*.

If the original curve represents a simple periodic current flowing in a conductor, the derived curve will represent the *rate of change of that flow* at each instant. The derived curve is a similar curve, but shifted backwards by one quarter wave length, so that its crests coincide with the hollows of the original curve, and *vice versâ*.

MR. STANLEY ON THE COMPARATIVE COST OF DISTRIBUTION BY DIRECT CURRENTS AND BY TRANSFORMERS.

In a paper lately read before the Boston Society of Arts Mr. Stanley gave the following figures as representing approximately the comparative cost of distributing electrical energy by the three wire system and by transformers:—

Distance, 3,000 feet. No. Lamps, 10,000. Maximum per cent. of Loss, 5 per cent. Copper at 18 cents per pound.

200-volt Edison "3-wire" System.	1,000-volt Induction System.
Conductors cost $126,634.00	Conductors cost $2,658.00
	Converters 30,000.00
	Total $32,658.00

Distance, 300 feet. No. Lamps, 500. Loss, 2 per cent.

Edison "3-wire" System.	1,000-volt Induction System.
Cost of Mains $156.00	Cost of Mains $3.60
	Cost of Converters 1,500.00
	Total $1,503.60

Edison "3-wire" 200-volt System.				1,000-volt Induction System.		
Per cent. of Loss in Mains.	Distance.	Number of Lamps.	Cost of Mains.	Cost of Mains.	Cost of Converters.	Total.
2	1,000	1,000	$3,511.00	$84.00	$3,000.00	$3,084.00
5	1,000	1,000	1,347.00	33.00	3,000.00	3,033.00
2	1,500	1,000	7,910.00	197.00	3,000.00	3,197.00
5	1,500	1,000	3,156.00	78 00	3,000.00	3,078.00
2	2,000	1,000	13,952.00	330.00	3,000.00	3,330.00
5	2,000	1,000	5,675.00	141.00	3,000.00	3,141.00
2	4,000	1,000	56,282.00	1,407.00	3,000.00	4,407.00
5	4,000	1,000	22,512.00	562.00	3,000.00	3,562.00

The paper continued as follows:—"From this table we see that at the present cost of converters, the two systems cost the same, with 2 per cent. loss at 1,000ft. distant, with 5 per cent. loss at a distance of 2,500ft. distribution; and at 5 per cent. loss the three-wire system is the most economical for shorter distances, while the induction system costs less for greater distances.

"The distribution of electrical energy by means of the high potentials and induction coils has almost annihilated the cost for the mains, while it has introduced the item of cost of converters. At present prices for converters and copper at twenty cents per pound, fifteen pounds of copper equal the cost of one lamp capacity in converters, and the purchaser has an equal option of using either the three-wire or converter system when distributing current at a distance of 1,100ft., with 2 per cent. loss; 1,500ft. with 5 per cent. loss, &c."

Mexican Import Duties upon Telegraph Material.—The *Two Republics* says that a notification has been published by the *Diario Oficial* exempting from duty posts, cross-trees, sticks, and conductors for telegraph and telephone lines.

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AUTHORSHIP OF ELECTROLYTIC THEORY.

(Translation of a Letter from Prof. Clausius, received by the Secretary of the Electrolysis Committee of the British Association.)

Bonn, 2nd October, 1887.

Dear Sir: While I render you my best thanks for kindly sending me the Report of the E.C.B.A., which I have read with much interest, I should like to be allowed to make a remark on one point arising in it. You mention the theory of electrolytic conduction, started by me in the year 1857, by the name, "the old Williamson-Clausius hypothesis;" and in similar terms my theory is referred to in other parts of the circular you have been good enough to send me.

This nomenclature must arouse in the minds of readers not fully conversant with the literature of the subject a question as to whether Williamson has not also devised a theory to explain electrolytic conduction.

This, however, is not the case. Williamson was only considering a purely chemical process, namely, the formation of ether, and his theory relating to this was contributed to the British Association in Edinburgh. On electrolytic conduction he had not spoken a single word. I am quite convinced that he himself has not the least intention of claiming the merit of having started a hypothesis for the explanation of electrolytic conduction.

By other authors the theory of electrolytic conduction is continually referred to as mine. Of English authors I will only mention Maxwell, who, in his "Treatise on Electricity and Magnetism," Vol. I., p. 309, speaks of "the theory of Clausius" simply.

I trust, therefore, that you will kindly arrange so that terms conveying a meaning not intended by the Committee may be avoided by them, lest they excite a false impression in the minds of readers.—With assurances, &c., faithfully yours,

R. CLAUSIUS.

REMARK BY DR. OLIVER LODGE ON THE ABOVE LETTER OF PROF. CLAUSIUS.

I have the greatest pleasure in bringing before the notice of the E.C.B.A. the remonstrance of Prof. Clausius, and shall hope to receive instructions from them at their next meeting. Meanwhile I may be permitted to state that the reason the nomenclature objected to has been so far partially and provisionally adopted is to be found in a paper by Dr. Williamson published in Liebig's *Annalen (Ann. d. Chem. u. Pharm.)*, Vol. 77, page 45, 1857. I merely mention this fact, without presuming to judge the question in any way.

O. L.

ON THE PROPERTY OF THE ALKALIES OF INCREASING THE E.M.F. OF ZINC.

It is now more than thirty years since Grove, Joule, Poggendorff, and others observed that the E.M.F. of the cells then in use was increased by replacing the dilute acid by a solution of caustic potash or soda. In a paper in the November number of *Wiedemann's Annalen* Herr J. H. Koosen gives an account of some recent investigations which he has made on this phenomenon. He points out that the increase must be due to chemical action, and not merely to the contact electrification. Numerous researches which have been made by the author prove, he considers, beyond a doubt, that the caustic alkali, to fix the ideas say potash, gives rise to a fourfold action.

(1). Caustic potash breaks up into its constituents. (2). Potassium takes the place of zinc in the electrical action of the cell. For example, in a Daniell's cell potassic sulphate (K_2SO_4) is formed in place of zinc sulphate, copper being deposited as in the ordinary arrangement. (3). The zinc is oxidised by the action of the oxygen of the caustic potash (KHO). (4). The resulting oxide of zinc is dissolved by the solution of potash.

(1) diminishes the E.M.F., (2) and (3) increase it. With regard to (4) Favre and Silbermann's researches tend to show that it is merely of the nature of local action, and therefore does not contribute to the electrical energy of the cell. It might, however, possibly slightly increase the E.M.F., but the effect would necessarily be very small, as the heat of combination of zinc oxide and potassium is only about 2 per cent of that produced by the decomposition of zinc in a Daniell cell. That the chemical actions are as described may be shown by dropping sulphuric acid into the zinc cell, when a white precipitate of oxide of zinc is produced, while in the other cell, the copper one in a Daniell, potassic sulphate is formed instead of zinc sulphate, and is deposited in the porous cell. The character of the cell is thus entirely changed, zinc only serving by its affinity for oxygen to facilitate the decomposition of the caustic potash. The author has limited his researches to the Daniell and a few other simple cells, as very little is known about the chemical action which takes place in most of the cells in general use.

Let the E.M.F. of an ordinary Daniell be assumed as the unit of E.M.F., and let the unit of heat be the amount generated in a Daniell cell by the decomposition of n grammes of zinc, where h is the atomic weight of that element.

If the external resistance be very great, practically the whole heat of chemical combination will be developed in the external circuit. Thus, from Thomsen's determinations, the E.M.F. of a Daniell is given by $Zn\,SO_4$ (248) - $Cu\,SO_4$ (198) = 50 = 1 Daniell. When potassium hydroxide (KHO) is used in place of sulphuric acid, K_2SO_4 (337) + $2Zn\,OH_2O$ (166) - 2 KHO (232) - $Cu\,SO_4$ (198) = 73 = 1·46 Daniell. For some of the other cells tried by him $Zn\,Br_2$ (91) = 1·82 Daniell; $Mg\,Br_2$ (165) = 3·3 Daniell; $K_2\,Br_2$ (180) = 3·6 Daniell; and for a zinc-potassium-bromine cell, $K_2\,Br_2$ (180) + $2Zn\,OH_2O$ (166) - 2KHO (232) = 114 = 2·3 Daniell.

From a practical point of view the author finds a Daniell with caustic alkali to be a good form of cell for giving long-continued currents through a large resistance. The chief point to be observed in using such a cell is to prevent, as far as possible, any diffusion taking place between the two fluids. The author has succeeded in effecting this by the use of a double porous cell containing a solution of potassic or sodic sulphate, as the case may be, and he finds that if a little sulphuric acid is added to this solution to improve its conductivity, the resistance of the cell is not very greatly increased. The alkaline solution must not be too dilute, or the zinc will soon become coated with oxide. Soda he finds preferable to potash, because, being more soluble in water, it does not so soon crystallise on the porous cell, thereby increasing the internal resistance.

The author considers that a zinc-platinum-bromine cell is far superior even to this modification of a Daniell for giving continuous currents through a high resistance. It requires no porous cell, and has been kept joined up through a large external resistance for four months without showing any perceptible diminution in its high E.M.F., which remains constant until one or other of the elements is entirely decomposed. The only precaution required is to cover the bromine with a layer of petroleum a few millimetres in thickness, which entirely prevents all smell or evaporation.

G. W. T.

THE LINEFF AND JONES ELECTRICAL TRAMWAY.

On Wednesday last we had an opportunity of examining an electric tramcar, designed to run on the "conduit" system, by Messrs. Lineff and Jones. The trials took place on the lines of the West Metropolitan Tramway Company, at Chiswick.

The car is of small size, being built to carry 20 passengers, and is fitted with a series-wound motor by the Immisch Company, running at 1,000 revolutions per minute, with 10 amperes at 230 volts, when the car is travelling at six miles an hour. The power is transmitted from the pulley of the motor by a Renold's chain to one of the axles, gearing down ten times. The current was supplied by a series-wound Immisch dynamo. In the middle of the track is a culvert

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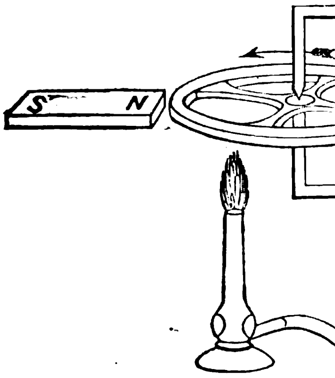
1ft. 7in. deep, formed of concrete, into which is built every two or three feet a sort of deep U-shaped chair. The legs of the U chairs support two longitudinal rails, which close the culvert all but a narrow slit $\frac{3}{4}$in. wide. The conductor is a bare No. 12 copper wire, run in screwed gas-barrel. This latter is held at each chair by a bracket, from which it is insulated by a serving of insulating tape. Iron forks are scrèwed into the barrel every few feet, their ends clamping down on the copper wire inside to secure good contact. The conductor is run well to one side of the culvert, so as to be clear of any dirt or water dropping through the slit. A flat iron plate at each end of the car runs in the centre slit, and between the two plates inside the culvert is hung a flexible conductor consisting of brass "beads" some two or three inches long and $\frac{3}{4}$in. diameter strung on a piece of stranded wire cable. This conductor rests in the iron forks on the gaspipe, never making contact with less than four at once, and, as far as we could see, picks up the current without any appreciable sparking. The lower part of the plate is, of course, bent to one side, so that the flexible conductor hangs in the line of the forks. The return circuit is through the side rails. The car is fitted with a break, worked by a long pull magnet, and the "cow-catcher" in front of the car is so arranged that on meeting with any obstruction it instantly reverses the motor. The lighting was by glow lamps, three in series, which were naturally anything but steady when the car was stopping or starting.

The chief feature which is special to the system is the method of making contact between the car and the fixed conductor, and this certainly appeared to answer the purpose extremely well, though it is of course impossible from a single trial run to form a definite opinion as to the merits of the device when employed on a large scale. Beyond this, there is nothing very novel in the system.

SCHWEDOFF'S THERMO-MAGNETIC MOTOR EXPERIMENT.

In reply to several requests for further information upon the experiment of Schwedoff, to which reference was made in



our recent article on M. Menges' thermo-magnetic generator, we produce herewith a sketch from which it will be readily understood. An iron ring is provided with four brass spokes, by which it is pivoted at the centre so as to be free to rotate in its own plane. A steel magnet is brought near one side, and at a distance of about 45deg. a Bunsen burner is placed. The magnetic permeability of the iron being greatly weakened by the heat from the flame, the effect is the same as if this part of the ring were made of brass or some other non-magnetic material; consequently the magnet tends to pull the ring round in the direction of the arrow, so as to restore the symmetry of the field. But as the hot part rapidly cools when removed from the flame, and the adjacent section is heated, the distribution of temperature, and therefore of magnetic permeability, remains fixed in space, and a continuous rotation is therefore set up. It is upon this action that M. Menges' generator is based, the field being, of course, immensely more powerful.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

(*Continued from page 260.*)

CHAPTER VII.—*Simple Tests with Indicators.*

73. Before leaving the subject of current indicators, or detectors, and proceeding to the consideration of current measurers, or galvanometers, it will be the attempt in this chapter to describe the methods of using the former instruments for some ordinary simple tests.

The most frequent use to which a detector is put is to ascertain whether a given circuit is metallically continuous, or, in other words, to test the circuit "for continuity."

(*a.*) *Tests for Continuity.*—In all electrical circuits containing apparatus in which certain contacts are "made" and "broken" at intervals, or continuous electrical contacts are made through moving parts of apparatus, such as the lever and axle of a switch or key or the carbon rod of an arc lamp, there exists a liability to loss of continuity through these contacts, either owing to their not being sufficiently clean, wearing away, oxidation, insufficient pressure between the surfaces of contact, or gradual fusing of the contact points as the result of sparking. Platinum is used for contacts, as it is a hard metal, and does not oxidise. As regards pressure between contacts a wheel or rolling contact is not so reliable as a rubbing contact where it is required to make continuous connection with a moving part. Switches for altering battery power or changing the connections of circuits are not considered reliable if they make more than three contacts at the same time. They are sometimes provided with screws for adjusting the pressure after the switch lever is in position, or, as in Hedges' form of switches for large currents, small independent springs exert a continual pressure between the lever and the contact. A later device still to ensure never-failing contact in a lighting circuit is to make the lever actually cut into the contact brass blocks, which latter are made of such a form that the wear can easily be taken up.

Where the pressure exerted is manual, as in the case of signalling keys in telegraphy, the operator easily acquires the difference in pressure requisite for working a long or short cable.

If sparking occurs between two contacts, such as would be the case if the contacts were required to effect intermittent short-circuit across the terminals of an electro-magnet through which a current was passing, or "make" and "break" its circuit, a high resistance, say of carbon connected permanently between the contacts, offers a path for the "extra current" from the electro-magnet, reducing the sparking and preserving the contact surfaces. It is seldom that wires connecting together parts of apparatus or leading wires running between different rooms of a telegraph or telephone office actually break, though they may do so in some cases, as for instance, if exposed to the corrosive effect of acid at any point, or if led round a sharp corner and subjected to strain or abrasion. But it is not at all an unfrequent occurrence for a contact to fail between a wire and the terminal to which it is screwed. Either the terminal is too large for the wire and does not properly grip it, or the wire has been bent in a loop round the terminal the wrong way—that is, in the direction *opposite* to that in which the screw turns, so that any extra tightening of the screw may force the wire out altogether; or the wire may be attached to a battery terminal which has become corroded and surrounded with crystals due to "creeping" of the battery liquid, in which case a bad contact would be made.

74. It sometimes happens that through failure of some contact in his own *receiving* circuit connections, the operator at one end of a telegraph line spends a long time in "calling up" the station at the other end, which, while answering all the "calls," is quite unable to speak to the station calling.

It is therefore one of the first considerations to look well after the receiving-circuit connections if no reply to a call is immediately forthcoming.

To illustrate this, a very simple example will now be taken of a fault of this kind occurring, say, in the receiving

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circuit of a single-current Morse signalling instrument. The illustration (Fig. 34) represents the apparatus usually mounted and connected together, and consists of a Morse ink-writer, M, sending key K, for transmitting signals by hand, line detector D (which can be short-circuited when not required by plugging *p* in *s*), and four terminals marked earth, line, copper, and zinc. The sending battery is, of course, external to the instrument, and is connected to terminals C Z. The sending key is a brass lever, movable about the centre *t*. The lever is generally electrically connected to *t* by a short flexible spiral of wire, since a failure of contact may occur at the axle about which the lever turns when manipulated. The back contact *b* is always closed when the key is at rest, the lever being kept in this position by the adjustable spring at the back. In this position it will be seen that, if there is no fault in the circuit, a current arriving from the line to the terminal L has a path open to it through the detector D, from *t* to *b* of the key, and through the electromagnet of M, to the terminal E, and thence to earth, completing the circuit back through the earth to the sending battery at the distant station. If there is some fault or break in this circuit, the detector already attached to the instrument can be readily used for localising it.

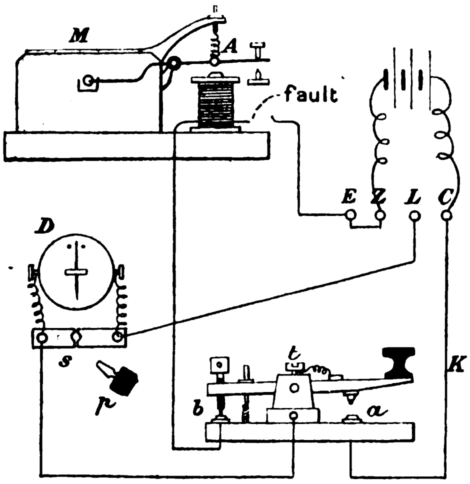

FIG. 34.

We will suppose the sending circuit to be all right. If this is not known it can easily be tried by connecting a wire between E and L, which short-circuits the instrument, and then if D is deflected every time the key is pressed it proves the circuit and the battery to be all right. Now disconnect the wire between E and L, and test the receiving circuit by taking the battery wire off C and putting it on to L, which connects the battery direct to the receiving circuit. No deflection will be observed on D, as there is some fault in this circuit. Disconnect the other battery wire from Z, and hold it in the hand so as to be able to connect it to different points in the circuit. We know the circuit is right from L to the key at *t* from the previous test, so that touching the end of the wire held in the hand on the metal at *t* we should get a deflection on D. Now, suppose that a deflection is observed when the end of the wire is touched at the lower contact at *b*; this shows that the back contact of the key is good. Also let deflections be noticed on touching the wire to the beginning and end of the electro-magnet coil of M, showing that the connection from *b* to the coil and the coil itself are all right. There is only one place now where the fault can be, which is between the coil and the terminal E, and on closely examining this connection underneath the instrument the break would be found, probably caused by the drawer containing the paper slip having chafed against the spiral of thin wire from the coil.

What has taken some time to describe here is really only the work of a few seconds, and it is quite a simple operation with practice and a knowledge of the circuits to speedily localise in this manner any fault in any set of connections, however complicated.

(*To be continued.*)

REVIEWS.

A Course of Lectures on Electricity, delivered before the Society of Arts, by GEORGE FORBES, M.A., F.R.S., &c. (London: Longmans, Green and Co., 1888.)

This is a reprint of the Cantor Lectures, delivered by Prof. G. Forbes in the spring of 1886, with the addition of a lecture on dynamo-electric machinery originally delivered at the Electrical Exhibition in Philadelphia in 1884 at the request of the Franklin Institute. The Cantor Lectures were fully reported in this journal at the time of delivery, but the present reissue has had the advantage of undergoing a further revision on the part of the author, and is also very fully and very well illustrated throughout. "The lectures," says the preface, "were primarily intended for an intelligent audience, ignorant of electrical science but anxious to obtain sufficient knowledge of the subject to be able to follow the progress now being made in the science." It will therefore be seen that this book in its present form appeals to a very wide circle of readers, and one for whom provision of this character has not hitherto been made by anyone nearly so well qualified for the task as Prof. Forbes. It is sufficient to add that the intention expressed by the preface will be found to have been admirably fulfilled.

SERIES GLOW LAMPS.*

BY WILLIAM SIEMENS.

The great obstacle which has hitherto prevented this system from coming into more extended use has lain in the manufacture of the lamp itself, for it is no easy task to make a good lamp with a filament large enough to take a current of some ten or more amperes.

One difficulty arises from the necessity for all the lamps to take the same current. An ordinary modern Edison lamp for parallel, running at 3·2 watts per candle-power, increases in resistance about 5 per cent. in an 800-hours' run; the old pattern used to increase about 13 per cent. in the same time. This increase, as has often been pointed out, has a preservative effect in a parallel system, but a destructive one when all the lamps are run in series, for in the latter case the same current has to pass through an increasing resistance, the work done in the lamp gets greater and greater, and the temperature of the filament higher and higher. A carbon, therefore, that is sufficiently good for parallel work would not do for lamps which have to run in series; but one must be used which does not increase so much in resistance when running. It may here be noted that series lamps, being almost necessarily of high candle-power, are mostly used for outdoor work, and therefore when competing with gas do not have any advantage over that rival on hygienic grounds, as is the case with parallel lamps in house work. It is therefore necessary that a series lamp should be more efficient than its congener if it is to stand an equal chance with it in respect to gas.

The firm of Siemens and Halske have been at work on the subject for some years, and are now making 11-ampere series lamps of 50 and 100 candle-power, with 10 and 20 volts respectively; an efficiency of 2·2 watts per candle-power, or 30 per cent. better than their parallel 16 candle-power lamps which require from 3 to 3·2 watts.

Although the carbon used is formed much in the same way as gas retort carbon, viz., by the dissociation of hydrocarbons, yet it possesses physical properties in which it differs not only from retort but also from all other kinds of carbon.

Its specific resistance is 689 microhms, that of a sample of bamboo carbon (unflashed) being 6,014. (Tabulated results of determinations of temperature coefficient of three Siemens and two unflashed bamboo carbons are here given for temperatures up to 200deg. C. The Siemens coefficient falls from about ·16 per cent. at 16deg. to ·12 per cent. at 200deg., while the Edison rises from ·029 to ·036 in one case and remains at ·026 throughout in the other.) The resistances of both carbons reached a minimum at a white heat when the total diminution of resistance was 55 per cent. for the Siemens and 45 for the bamboo. The specific gravities were 2·01 and 1·58 respectively.

All the above properties show the value. of this carbon for the purpose required, and after a 500-hours' run the resistance of a lamp was found to have hardly perceptibly increased; and the efficiency had fallen from 2·25 watts per candle-power to 2·35.

Besides the carbon other difficulties have to be encountered in large current lamps, in the matter of making good connection to the carbon and of fusing the platinum wires into the glass.

* Abstract of a paper read before the Electrotechnische Verein, Berlin, 27th December, 1887.

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The usual horseshoe filament (or, in this case, rather horseshoe rod) is found to be the best in this as in the ordinary parallel lamp, although, at first sight, a straight rod with leading-in wires opposite to one another would appear preferable. The wires are very long and thick, and naturally very difficult to seal in air-tight. The ends of the filament are considerably enlarged and electroplated (with nickel) into metal cups, which in turn are soldered on to the platinum wires.

The author then describes a rather complicated mechanical device for short-circuiting a lamp when it breaks.

The alternating has a great advantage over the direct machine for series running, owing to the automatic regulation caused by the self-induction of the armature. A Siemens alternating running at 1,700 volts, with 11-ampere glow lamps of 60 and 100 candle-power, caused no injurious alteration in the remainder when one-third of them were suddenly short-circuited, a greater alteration than would ever occur in practice.

The author goes at considerable length into the *pros* and *cons* of series running as compared to parallel. The chief argument brought forward in favour of the former system arises from the fact that the distance from the central station at which lamps may be economically run is much increased. Where it is *necessary* that this distance should be very great the series system should undoubtedly be employed. The distance for parallel working is, however, no small one. For example, at Eberfeldt the author's firm have installed a central station on the three-wire system for 10,000 16 candle-power lamps, feeding a district some 2½ kilometres (1·5 mile) across.

He is of opinion that the series system has but a limited field, being practically only suitable for streets, tunnels, stations, mills, &c., where lights of 50 and 100 candle-power are wanted, and for which use it has a great advantage over the arc lamps in only requiring attention once in 800 hours instead of once in 8.

The author strongly attacks the Bernstein system of house-to-house lighting by series lamps, on the ground that the lamps cannot be satisfactorily made of sufficiently low candle-power, that they are three times as expensive as parallel ones, that there is considerable danger to life, and lastly, that it is no cheaper, if indeed as cheap, as parallel installations on the three-wire system. The cost for mains he admits is only one-third or one-half of that for parallel running, which he puts at 30s. per 16 candle-power lamp; but against this saving there is the cost of the automatic short-circuiting arrangements, and these, he says, will cost as much as to lay down the mains for the whole district on the three-wire system. Besides, the cost for mains is, after all, only a portion of the total expenses, and the depreciation on them is not nearly so heavy as on the dynamos and other plant.

The rest of the paper and the whole of the discussion deal with the effects of high potentials on the human body, and of this we hope to give an abstract in a future issue.

ELECTRIC LIGHTING OF TRAINS.

At the recent meeting of the International Railway Congress the following report was presented by the management of the Belgian State lines upon the subject of the electric lighting of trains :—

The different sources of electricity which have been tried are: (1) Primary batteries; (2) accumulators, or secondary batteries, placed (*a*) in the van or baggage car, (*b*) in each car, so as to render the lighting independent; (3) a dynamo electric machine connected to one of the axles with accumulators to keep up the lighting when the train is at rest; (4) a dynamo operated by a special motor placed on the locomotive or the baggage car, and supplied with steam from the engine or a special boiler.

Electric light presents the advantages of brilliancy, whiteness, steadiness, ease and convenience of management. Some of the difficulties are: Cutting up trains, if the supply be from a single source for the whole train, cuts off the cars from the light. The apparatus is usually complicated or delicate. The cost is not yet certainly known. If accumulators are used, the question of cost, &c., becomes still more complicated. To increase the life of the lamps it has been proposed to shut off part of the light when the full power was not required. The introduction of compound-wound dynamos has, however, obviated some of the difficulties formerly experienced in train lighting.

(1.) Primary Batteries.—Primary batteries cannot generally produce electricity economically, but it has been attempted to use such batteries for train lighting on the Midland and South-Eastern. On the Midland each car has six 5 candle-power lamps; there were 15 Holmes and Burke elements put together in series of five elements each, and the electromotive force of each element was 1·85 volt, and its internal resistance 1-40th of an ohm. The light lasted ten hours without renewing the battery, but it was necessary to amalgamate the zincs twice a week. The solution around the zincs was a mixture of one part sulphuric acid and 12 of water. Around the carbon element was some kind of salt, precisely what is not stated. Similar results were obtained on the Great Northern, the South-Eastern, and the London and South-Western. The cost is unknown, but as the battery has not come into extensive use it is to be presumed that it is too high.

Inventors are still coming to the front with primary batteries, which are announced to be capable of producing electricity for almost nothing; but trials have demonstrated very clearly that to produce electricity by the consumption of zinc, or some other equally high-priced metal, is, at least, ten times more expensive than to get it from dynamo machines. The International Sleeping Car Company is running a car daily between Brussels and Paris lighted by 14 electric lamps said to be of 10 candle-power, but really giving only seven or eight. The experiments are under the charge of M. L. Desruelles, an engineer of Paris. There are 45 elements, connected 15 in series and three in quantity. The zinc electrode is immersed in a solution of bisulphate of mercury, and the carbon in a mixture of bichromate of soda, sulphuric acid, and nitric acid. A charge of liquid lasts during four trips of seven hours each, and the zincs must be replaced by new ones about every sixteenth trip. Primary batteries have the advantage of being easily placed under each car, and susceptible of making the light of each car independent.

(2.) Secondary Batteries.—The London and Brighton made a prolonged trial of lighting by accumulators, taking them out for charging. It considers that the labour required for this is an obstacle to their practical and economical use. It also necessitates the erection of a sufficient number of charging stations, or the transportation of the batteries to and from the place of charging. The placing of accumulators under each car would, as in the case of primary batteries, render the lighting of each car entirely independent. The Paris and Orleans also made some experiments with primary batteries, arranged (1) to charge the accumulators alone without feeding the lamps; (2) to feed the lamps from the accumulators only; (3) to charge the accumulators and feed the lamps at the same time. The accumulators were of the Faure type, and a sufficient number were carried to light the lamps for twenty or thirty hours. They were placed under the seats, and the weight required was 450lb. to 650lb. per car. Two Swan lamps of 10 candle-power were used in each compartment. Lighting by means of accumulators can, of course, only be done with considerable loss, but this system seems to have the best chance of success, although these particular experiments did not succeed well, owing to the destruction of the plates and leakage of the boxes, and the difficulty of maintenance. Improvements in the accumulators may improve the conditions and reduce the cost.

(3.) Dynamos Connected to a Car Axle, with Accumulators as a Reserve.—The great difficulty of obtaining a regular current from the dynamo connected to a car axle makes the employment of accumulators as a regulator very important. They are necessary also to maintain the lamps lighted when the train stops at a station or elsewhere. Automatic appliances must be provided which shall cut off the current from the dynamo when it falls below a certain speed in order that the batteries may not discharge themselves through it. The dynamo must either always turn the same way or means must be provided for always delivering the current to the batteries in the same direction. There are many devices for this purpose. Many railroads have tried this method. The transmission from the axle to the dynamo has been accomplished by belts, gearing, friction cones, worms, &c. Magnetic transmission has also been tried. None of these methods have been satisfactory, though the friction method gives the best results. A novel method has also been used by Preece and James, where a system of excentrics on the axles compressed air, which was afterwards used in Brotherhood motors. The accumulators, instead of being in the car with the dynamo, are sometimes placed in every car in the train, but this increases the complication, though the cars are thus independent of each other, so that the cutting or breaking apart of the train does not extinguish the light. Besides the loss of electricity by the use of accumulators this method requires a special car and a man to manage the apparatus, which greatly increases the expense. The London and Brighton, however, after a prolonged trial of accumulators charged at one end of the line, has now abandoned that system, and uses a dynamo driven by one of the axles for charging accumulators.

(4.) Special Motor Operating a Dynamo.—This scheme introduces more objectionable features than the preceding. The principal disadvantages are: (1) The extra consumption of steam, which for a small motor is usually very high; (2) the care of the apparatus would be of necessity given to the engineer, who already has enough to do; (3) every time the engine was detached from the train the lamps would be extinguished; (4) a breaking apart of the train would leave the rear portion in darkness; (5) if the motor is placed in a car behind the engine it requires a special attendant

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for this car to go with the train. This apparatus makes a considerable addition to the dead load of the train, and the cost of attendance is larger; (6) to render the lighting perfectly satisfactory accumulators must be used to regulate the light and maintain it while the engine is detached from the train. The London and Brighton is lighting its "Pullman Limited Express" in this way. In the van is a small Brush dynamo operated by the rear axle by means of belts. There are 86 lamps of 16 candle-power each and a battery of 24 accumulators attached to this dynamo. In the daytime the dynamo charges the accumulators and the lamps are used only when passing through tunnels. The expense of lighting this train is not given, but it is said to be too costly for ordinary trains.

The management of the Royal railroads at Frankfort-on-the-Main has experimented with electric lighting. Three cars were fitted with lamps, and a dynamo and 26 accumulators were in the van, the dynamo being operated from one of the axles. The dynamo and accumulators weighed about 1,320lb., and cost $625. The lamps in each car cost about $20. The lighting costs two cents per lamp per hour, while gas-lighting on the State roads of Belgium costs exactly 0·28 cent per burner per hour.

In 1884 the Metropolitan District tried lighting by a dynamo and special motor. The total weight was over three tons, including water and fuel. A Siemens dynamo feeds 52 lamps of 18 candle-power each for eight hours per day. Three cubic feet of water were evaporated at a pressure of 185lbs. per square inch. Only 4½ horse-power appeared as electric work in the lamps and conductors, the rest being absorbed by friction, &c. This experiment was not satisfactory, as the boiler fouled very quickly, and had to be taken to the shop for cleaning. In the experiments made on the Wurtemburg railroads in 1886, the dynamo was run by a belt from a pulley on one of the axles of the baggage car. An electric regulator was used, and a number of accumulators sufficient to keep the lamps lighted for five hours were placed in each car. The accumulators were put in circuit to be charged only when the speed of the train reached 20 miles an hour. When the current became too great it was automatically interrupted. The current was divided between the lamps and the accumulators, and when the train stopped, these latter furnished the current for the lamps until the train was again running at 20 miles per hour. The dynamo worked whether the train went forwards or backwards, because the brushes adjusted themselves automatically to the direction of the train. It appears that the accumulators worked satisfactorily. The lamps were of the Bernstein system, and the accumulators of the Khotinsky type. An express train running between Vienna and Trieste was fitted with a dynamo and Calo accumulators, 28 in number, weighing 37lb. each. They were sufficient for lighting 40 lamps of eight candle-power each during the stops of the train. The dynamo at 1,200 revolutions gave 100 volts and 50 amperes. It had an automatic compensating apparatus for regulating the flow of the current into the accumulators or the lamps, or both at once. The lighting was for about 15 hours per day. The trials appear to have been satisfactory. A train running between Munich and Starnberg was lighted by a dynamo run by an Abraham four-cylinder engine. The light was very unsteady. In England a similar experience was had with a Willans motor and a dynamo. A mixed system devised by M. Donato Tommasi burned gas during the stops of the train, electricity furnishing the light when the train was in motion. The electric current partially shut off the gas. This does not appear to be a practical system. The trains while passing through the tunnels on the Glasgow underground are lighted by electricity. A third rail laid between the other two is carefully insulated and connected to one pole of a dynamo, the other pole of which went to earth; the two outside rails of the track are also grounded. Rollers under every car make contact with the third rail and convey the current to Swan lamps in the cars, the current returning to the dynamo through the wheels and the earth. The lamps were thus automatically lighted on entering the tunnel and extinguished on leaving it.

Electric headlights have been used between Munich and Tolz, Strasbourg and Wissenbourg, on the Northern of France, and on the State Railway of Austria. The Northern of France rejected the system not because of its working badly, but on account of the expense. No information has been obtained regarding the experiments in Austria. Among the chief difficulties to be overcome was the jarring of the locomotive. It is also difficult to keep the arc in the focus of the reflector. Another serious annoyance is the placing of an electric machine upon the locomotive.

All the foregoing trials demonstrate the possibility of lighting trains by electricity, but the question of the most practical system is not yet solved. All the systems of electric lighting of trains not known would at least double the regular cost for maintenance, beside the first cost of the apparatus, which should also be considered. In the present state of the question electrical lighting appears too expensive except in special cases where its use is justified as a luxury, and the expense is only a question of secondary importance.

MEETINGS OF SCIENTIFIC SOCIETIES.

(Week ending Friday, 3rd February.)

TO-NIGHT (FRIDAY), January 27th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read, "Pumping Machinery in the Fenland and by the Trentside." By Mr. LAWRENCE GIBBS, Stud I.C.E.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Indian Section. "The Public Health in India." By Mr. Justice CUNNINGHAM, of the High Court of Judicature, Calcutta. Sir DOUGLAS GALTON, K.C B., F.R.S., will preside.

PHYSICAL SOCIETY OF GLASGOW UNIVERSITY.

Paper on "The Electrolysis of Copper in Standardising Electrical Instruments." By Mr. A. W. MEIKLE.

ROYAL INSTITUTION.

9 p.m. Lecture, "The Exploration of Masăi Land." By Mr. JOSEPH THOMPSON, F.R.G.S.

SATURDAY, January 28th.

ROYAL INSTITUTION.

Lecture, "Experimental Optics." By Lord RAYLEIGH, M.A., &c.

PHYSICAL SOCIETY.

3 p.m. "The Effect of Magnetisation on the Thermo-Electrical Properties of Bismuth." By Mr. HERBERT TOMLINSON. "The Influence of Magnetism and Temperature on the Electrical Resistance of Bismuth and its Alloys with Lead and Tin." By Mr. E. VAN AUBEL. "On a Water-Dropping Influence Machine, and on the Price of the Factor of Safety in Lightning Rods." By Professor S. P. THOMPSON.

MONDAY, January 30th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II. The first of a series of four Lectures on "Yeast, its Morphology and Culture." By Mr. A. GORDON SALOMON.

TUESDAY, January 31st.

SOCIETY OF ARTS.

8 p.m. Applied Art Section. "The Monumental Use of Bronze." By Mr. J. STARKIE GARDNER, F.G.S. Mr. J. POYNTER, R.A., will preside.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed, "The Erection of the 'Jubilee' Bridge, carrying the East Indian Railway over the River Hooghly, at Hooghly." By Sir BRADFORD LESLIE, K.C.I.E, M.Inst.C.E. Paper to be read, time permitting, "The Alexandra Dock, Hull." By Mr. A. C. HURTZIG, M.Inst.C.E.

ROYAL INSTITUTION.

3 p.m. Lecture, "Before and After Darwin." By Mr. GEO. J. ROMANES, M.A.

WEDNESDAY, February 1st.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Functions of the Middleman in Relation to Labour." By D. F. SCHLOSS.

THURSDAY, February 2nd.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

3 p.m. Lecture, "Art Education." By Mr. HERBERT HERKOMER, M.A., A.R.A.

CHEMICAL SOCIETY.

8 p.m. Meeting.

SOCIETY OF ARTS.

8 p.m. The first of a series of three Lectures on "Etching and Mezzotint Engraving." By Prof. H. HERKOMER, A.R.A.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Meeting.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

Students' Meeting. Discussion on the recent Paper by Prof. FLEMING, Mr. GIMINGHAM, and Profs. AYRTON and PERRY, will be opened by Mr. C. G. LAMB, B.Sc.

FRIDAY, February 3rd.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Meeting.

ROYAL INSTITUTION.

9 p.m. Discourse on "Ancient Microscopes." By Mr. FRANK CRISP, LL.B., B.A., M.R.I., V.P. and Treas. Linn. Soc., Sec. R.M.S.

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The Electrician.

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THE WORLD'S ELECTRIC INDUSTRY.

During the past year, which was the year of Jubilee for the Electric Telegraph, many attempts were made to estimate the material, social and political advantages derived from the adoption of electricity as the world's swift messenger. The subject was so vast, the consequences so far-reaching, and so intermingled with other active agencies, equally progressive, during the same period, that little more than bold but magnificently vague generalities could be arrived at, and we were left with the comforting but intangible reflection that the electric telegraph had done such wonders nobody was able to estimate them. Mr. GRAVES has carried us a little nearer to a practical realisation of our indebtedness, and, what is more, has indicated the road we must take to estimate its fulness. In his presidential address to the members of the Society of Telegraph-Engineers and Electricians Mr. GRAVES undertook the initial but very formidable task of enlightening us as to the actual extent of the electric industries of the world, how many people are engaged in it, how many live upon it, and how many are industrially more or less concerned with it. In such a survey the electric telegraph still takes a prominent, but not the preponderating, part it occupied at the period from which Mr. GRAVES dates his connection with it. Other industries of vast dimensions have sprung up which owe their origin and development to electricity, and according to his estimate almost as many people are occupied in electric lighting, electro-plating, and kindred manufactures dependent upon them, as in working the telegraphs. Aggregating the whole field of electrical industry known to us, and estimating the number of hands they employ on the basis of figures obtained from reliable sources in this country, Mr. GRAVES has placed before us for the first time some tolerably safe calculations on this interesting subject, and the results are very striking.

Beginning with the fact that in the United Kingdom there are 229,000 miles, or thereabouts, of public telegraph wires, employing 23,868 persons, Mr. GRAVES computes that on the world's telegraph lines, approximately amounting to 1,800,000 miles, not including submarine cables, a total number of 179,748 persons find their occupation exclusively in telegraphic signalling operations. From this computation are

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excluded persons who only partially are so employed, as, for instance, on railways and in post offices where telegraphy is only a subsidiary part of their duties, and who, if they had been included in the basis of calculation, as indeed they partly ought to be, the grand total would have been immensely swollen. But taking the basis of exclusive occupation, and proceeding in the same way with cable telegraphs and telephones, Mr. GRAVES sets down the *employés* of the former at 6,000, almost exclusively British, and of the latter at 30,000, covering, of course, the whole world. This gives us a grand total of 216,000 operators, a number which is increasing every day with great rapidity all over the world with the spread of the telegraph and the telephone and the laying of fresh cables. Mr. GRAVES describes himself as a mere stander-by, who has simply watched the progress of telegraphy for the space of thirty-six years. No one who knows him would accept this modest estimate of the part he has played in the history of the industry with which his name is so closely identified; but the most presumptuous of men might join in his exclamation, "I am struck with astonishment," when he recalls the smallness of its beginnings, and the littleness of its knowledge in 1852, compared with what the telegraph has grown to be to-day.

By a similar method of computation the figures relating to the other electric industries are arrived at. But Mr. GRAVES very justly pointed out that at the time above referred to the working of the telegraph was, broadly speaking, "the sole demonstration of electricity that could be commercially cultivated." Since then new fields for its application have been opened up which were then undreamed of, but largely owing to the success attending its adaptation to the needs of the community as a signalling agent. The mind of the student was set free, and the spirit of unshackled inquiry soon discovered fresh work on which this natural force could be usefully and profitably employed. So fruitful have been these discoveries that in one English manufacturing town alone there are 5,000 hands engaged in electro-plating and electro-gilding processes; and in this regard Sheffield, the town referred to, is probably not far ahead of Birmingham. But these and their allied industries, dependent for their success on the discoveries of electrical science, are so widely spread that it is impossible to state, except conjecturally, how many persons are engaged in them, but the total for the whole industrial world must be very large indeed. In the manufacture of submarine cables, and of insulated wire, an industry which is far more concentrated, the *employés* are ascertainable, and average about 5,000. For the electric lighting industry Mr. GRAVES has assigned a gross total of not fewer than 100,000 persons, on the basis that at least 5,000 are employed upon it in our own country. High as his estimate may appear at first we feel sure that, like those for the rest of the classified electric industries, Mr. GRAVES has understated rather than overstated the facts; and if this is the case the rapidity with which this quite new employment has grown is at once remarkable and encouraging.

Putting all these estimates together we arrive at some general conclusions like the following:—Adding to the 216,000 persons employed in electrical signalling the 105,000 engaged in the supply of cables and electric lighting, we have a total of 321,000. But this is very far indeed from representing the actual total of persons whose living directly depends upon electric industry, although not immediately connected with it. Of these it may suffice to mention the wire drawers, iron workers, copper smelters, timber growers and their workmen, creosoters, insulator makers, brass workers, engine builders, boiler makers, glass blowers, mechanicians, carbon manufacturers and the like, whose total number Mr. GRAVES—who ought to be a trustworthy authority on the extent of these subsidiary industries—estimates at about equal to that of the persons distinctly classified in electrical callings. In the United Kingdom, according to this, about 100,000 persons depend for their livelihood upon industries which, but for the practical utilisation of electricity, would have no existence; and reckoning only three for the family, instead of five, or four and a-half, where adults only are employed, these industries provide support for 300,000 persons. Multiplying this by the proportion which the electric industries of this country bear to the rest of the world, there must be, Mr. GRAVES concludes, at least 5,000,000 of people who would have to look to other means of subsistence "if electricity and its commercial applications had not been made known to man."

Calculations such as these do not bring us much nearer to the measure of those advantages to which we adverted in the opening sentences of this article. But they are eminently practical, and they go a great way towards rendering the more fanciful speculations superfluous. We may rest content with the substantial blessings enumerated by the President of the Society of Telegraph-Engineers and Electricians, who naturally prefers to emphasise the ascertainable benefits conferred by the practice of his profession, rather than to balance the evil and the good which social and political life may extract from it. In one other way the new president showed the practical bent of his mind. Although all his working life has been devoted to the telegraph service, he frankly confesses that telegraph engineering has ceased to occupy its once undisputed pre-eminence in the field of applied electricity. Other branches of electric industry are now running it closely, and he is magnanimous enough to admit that the society with which he has been so long associated as a telegraph-engineer, and over which he now presides, ought to mould itself to the times, and change its title to the more comprehensive one of ELECTRICAL ENGINEERS. Coming from a representative of the most powerful element in the society, this announcement, which was well received by the members who heard it, can hardly fail to be carried out during Mr. GRAVES' term of office.

CENTRAL STATION INDICATING INSTRUMENTS OF THE EDISON COMPANY.*

(Continued from page 268.)

The Edison three-wire system, as is well known, is made up of two multiple arc systems connected in series, with the wire, which is common to both, connected to the source of current in such a way as to give to each all the advantages of a simple multiple arc system. These two systems, known as the two sides of the three-wire system, are intimately associated, the same current being used in both. Nevertheless, as far as regulation is concerned, they are almost absolutely independent. The two sides have separate indicating and regulating apparatus, and the regulation of each side is performed without any reference to the other. As most consumers get half their lamps from each side, it is very necessary that the pressure on both sides be the same; otherwise a difference between the brightness of the lamps on the two sides will be noticed.

It is the function of the balance indicator to show at all times whether or not the pressures on the two sides are the same.

In connection with the pressure indicator there is employed a galvanometer which in the three-wire system acts as a balance indicator, and thus indicates whether the pressure on both sides of the system is the same.

Its function is shown in the diagram, Fig. 6, which shows a pair of pressure indicators connected to the pressure wires from a feeder end on the three-wire system. R R are two equal high resistances,

* From the New York *Electrical World*.

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and B the galvanometer; R, R and B are connected as shown directly to the three-wire circuit. The point C is electrically midway between the + and − wires, and its potential is half way between the potentials of the + and − wires. When the pressures on the two sides at this point are the same, the potential of C′ is also midway between the potentials of the + and − wires. Then the points C and C′ are at the same potential, and no current flows through B, and it remains at zero. If, however, the pressures on the two sides are not the same, then the potential of C′ is not midway between the potentials of the + and − wires, and C and C′ are not at the same potential. A current then flows in B which deflects the needle, and the direction of deflection shows which side is highest.

On a three-wire system using the comparative method of indicating pressures, which will be described later on, only two absolute pressure indicators are used, one on each side of the system. If one of these changes, the pressure on all that side changes, as the comparative indicators simply copy the pressure kept by this indicator. If, however, there is a balance indicator connected around the two indicators, any change in either one of them is immediately shown and can be remedied. In the diagram S S indicates lamp sockets. If at any time it is necessary to take down one of the two pressure

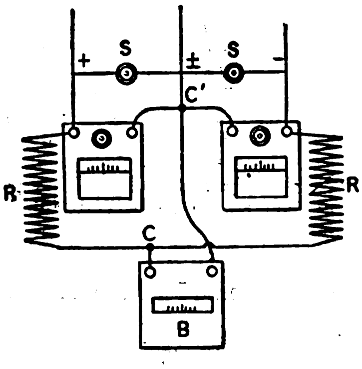

Fig. 6.

indicators, the lamp from this indicator can be screwed in the socket above the indicator taken out. The pressures can then be regulated by one pressure indicator and the balance indicator, the one pressure indicator holding the desired pressure on one side, and the balance indicator showing when it is the same on the other side. The galvanometer used for the balance indicator is also used in throwing dynamos in circuit.

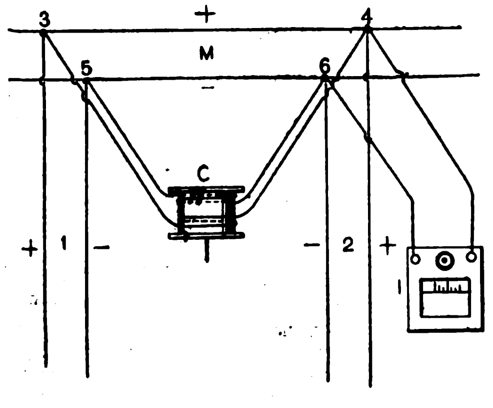

Fig. 7.

In distributing currents at constant E.M.F. it is necessary to maintain the same pressure at the ends of all the feeders, and this may be accomplished by connecting a pressure indicator to each side of each feeder end, and regulating each point by reference to these pressure indicators. This method, in a three-wire system, evidently requires twice as many pressure indicators as there are feeders, each one of which has to be kept in adjustment. The same result, however, may be accomplished by maintaining the desired pressure at the end of one feeder by reference to pressure indicators, and at the other feeder ends by reference to comparative indicators. The advantage of this method is that the two pressure indicators only need to be kept in adjustment; the comparative indicators being once set up require practically no attention.

Fig. 7 is a diagram showing the principle upon which this indicator operates. In the diagram M is the distributing circuit, and 1 and 2 are feeding circuits. At the point where feeding circuit No. 2 joins the distributing circuit, a pressure indicator, I, is connected, by reference to which the pressure at that point is kept at the desired standard. C is a differential galvanometer, or "comparative indicator," connected as shown, one coil being joined to points 3 and 4, and the other to 5 and 6. If now the points 3 and 4 be at the same potential and the points 5 and 6 be also at the same potential, then the difference of potentials or pressures at the end of feeder No. 1 is the same as at the end of feeder No. 2. No current will flow from 3 to 4, nor from 5 to 6, and the galvanometer C will remain at zero. Again, if the point 5 be at the same potential as the point 6, but the point 3 be at a different potential from the point 4, there will then be a current in the coil connected between 3 and 4, and the galvanometer will show a deflection one way or the other, depending on whether point 3 is higher or lower than the point 4. Under these conditions, C would give a deflection, as the pressure at the end of feeder No. 1 is not the same as at the end of feeder No. 2. If, now, the + wire of feeder No. 1 be adjusted until 3 is at the same potential as 4, C will come to zero, for then the pressures at ends of No. 1 and No. 2 are equal. Instead of adjusting the + wire of feeder No. 1, the − wire of feeder No. 1 may be adjusted to bring the galvanometer C to zero. When C is brought to zero in this way the point 5 is made just as much higher or lower than 6 as 3 is higher or lower than 4. There are then currents in both coils of the galvanometer C, but they will be equal and balance each other, and C will remain on zero, as it should, since the difference of potentials or pressure at the two feeder ends is the same.

The diagram, Fig. 8, shows the manner in which the comparative indicator is applied. There are here shown the pressure wires from three feeders—No. 1, the standard feeder, and two others. From each feeder a set of iron pressure wires is run; these are marked I I, and the points on the comparative indicators to which they are connected are also marked I. From the end of feeder No. 1 an extra set of pressure wires is run; these are of copper wire and run to all the comparative instruments, as shown, being connected

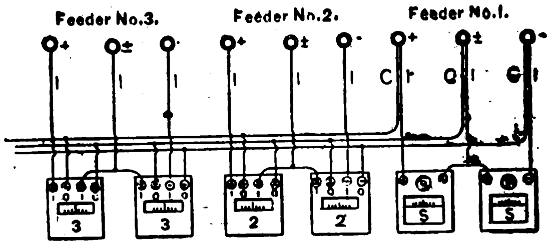

Fig. 8.

to the point marked C. This is the manner in which the comparative instruments are connected in all three-wire systems, except that in some systems only one set of pressure wires is used on No. 1 feeder. When connected as shown, the pressure at the ends of feeders Nos. 2 and 3 is compared with the pressure at end of feeder No. 1, and when all the comparative indicators are at zero the pressure at the ends of all three feeders is the same.

Portable Voltmeter.

All the instruments thus far described are designed to remain permanently in position, but it is frequently desirable to measure the potential at various points in a circuit, since the indicators at the station give the pressure at the feeder ends only. For this purpose the voltmeter, illustrated in Fig. 9, is employed, the engraving showing the instrument removed from its case, in which it can be readily carried about from place to place.

The operation of this instrument is based on the well-known "potentiometer" or "opposition" method of measurement.

The voltmeter contains a small Daniell cell of known constant E.M.F. The E.M.F. of this cell is opposed to the E.M.F. in a part of the voltmeter circuit, and this part can be varied by moving a sliding contact, to which one terminal of the battery is connected, along a resistance forming part of the voltmeter circuit. When the E.M.F. in this part of the voltmeter circuit, around which the battery is connected, is equal to the E.M.F. of the battery circuit, to which it is opposed, no current will flow in the latter, and the galvanometer which is included in it will show no deflection.

The diagram, Fig. 10, shows the circuit connection of the instrument. P P′ are the terminals to which the circuit to be measured is connected; B is the battery of known E.M.F.; G, a galvanometer; C, a contact that is adjustable along a resistance of 20 ohms; S, a switch closing the circuit from P′ through the battery and galvanometer to the contact C. We will assume that the circuit is closed from P′ through B, G, C, part of the 20 ohms, and

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the 40 ohms back to P′. We will also assume the positive pole of the battery and the positive pole of the circuit to be measured are both connected to P′, and that a current is flowing from P′ to P. Then, in this closed circuit, two electromotive forces exist, which tend to set up currents in opposite directions through battery B and galvanometer G. The battery tends to send a current through G from left to right, and the E.M.F. of the circuit itself tends to make a current pass from P′ to C through G; *i.e.*, from right to left. Hence, when the E.M.F. from P′ to C is equal to the

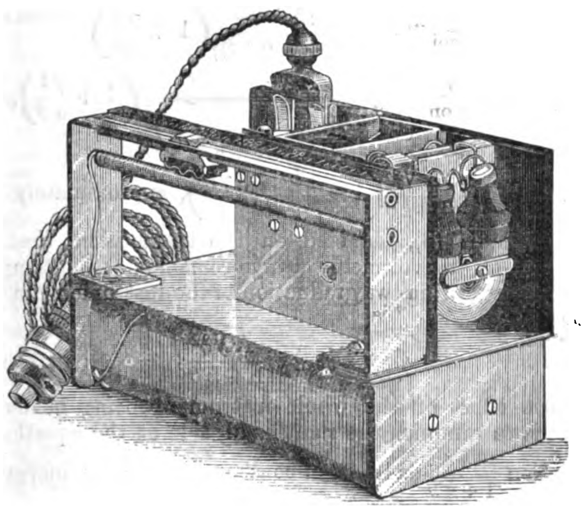

FIG. 9.

E.M.F. of the battery, no current will flow in G, as the two equal E.M.F.'s are opposed to each other, and thus prevent a current from flowing in the galvanometer circuit. Knowing now the E.M.F. of the battery, and the value of the resistances, it is only necessary to know the position of C along the 20 ohms to determine the E.M.F. acting from P′ to P, which is the quantity we wish to measure. The voltmeter is supplied with two standard cells, which can be readily removed for renewal when necessary. By simple

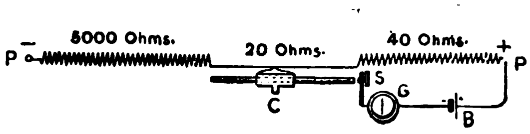

FIG. 10.

sliding connections these may be arranged either in multiple or in series. When the cells are in multiple the pressure necessary to balance the instrument is read directly off the scale in volts; when placed in series the pressure required to balance the instrument is given by doubling the scale reading. The scale usually reads from 90 to 130; with the batteries in series it reads from 180 to 260 volts.

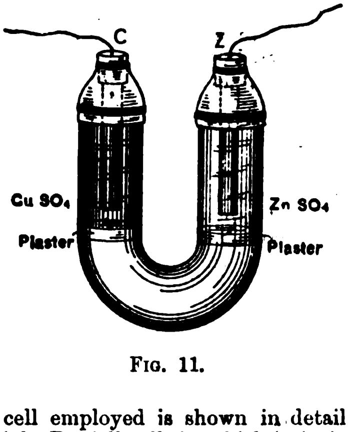

FIG. 11.

The standard cell employed is shown in detail in Fig. 11. It is a portable air-tight Daniell cell, in which it is impossible for the copper sulphate to come in contact with the zinc electrode for three or four months, and during this time the slow progress of the copper sulphate towards the zinc electrode is plainly visible. The cell consists of a V-tube, the bend being filled with a paste. In each leg of this tube is placed respectively a rod of copper and zinc, dipping into the sulphate solution of the same metal.

The blue copper sulphate colours the whole paste as it advances; the line between the blue and white is plainly marked, and, as time passes, the blue reaches the end of the white paste, after which if it goes further, it will reach the zinc electrode. The battery is then removed and a fresh one inserted. In this way all the trouble of cleaning out and refilling batteries is done away with. The ends of the glass U-tube are closed with rubber tubes, one end of which is stretched over each end of the glass tube, and the other end enclosing the electrode. It is impossible for a battery to leak unless the rubber tube slips off the tube or makes an imperfect joint, neither of which is likely to happen. The copper sulphate solution, as it colours the whole paste, combines with it, and the new compound occupies less space than the constituent substances, so that an inward pressure or vacuum is formed which helps to keep the cell tight.

The use of the voltmeter is quite simple. As will be seen in Fig. 9, a plug is inserted between two contacts, and is connected by flexible cords to another plug, which is inserted into the lamp socket at the point it is desired to test the E.M.F. of. The variable resistance is mounted on a spool, and the sliding contact moves along a scale marked to read volts. When, upon the depression of the key beside the galvanometer, the latter shows no deflection the number of volts can be read directly off the scale.

The principal use of the voltmeter is to determine the pressure *at the lamps* in different parts of the circuit. In central stations a constant pressure is maintained at the feeder ends; the voltmeter enables one to determine just what the pressure is at any point of the circuit. Points distant from the feeder ends necessarily have a lower pressure than the latter, and by means of the voltmeter the exact difference can be determined, and if the difference is too great its cause can be looked for and remedied. Another use for the voltmeter is to measure the loss on pressure wires carrying the indicator currents to the central station.

DEVELOPMENT OF THE TELEPHONE IN AUSTRIA.

In 1883 the subscribers to the eight Exchanges of the Telephone Company of Austria (Limited), viz., Prague, Trieste, Lemberg, Graz, Czernowitz, Pilsen, Reichenberg, and Bielitz-Biala, numbered 442, with 40 private lines; in 1884, they increased to 759 exchanges and 66 private lines; in 1885, to 1,129 exchanges and 72 private lines; in 1886, to 1,627 exchanges and 72 private lines; and in 1887, to 1,950 exchanges and 72 private lines. The calls were, in 1883, 838,690; 1884, 739,258; 1885, 1,089,626; 1886, 1,850,116; and in 1887, the average varied between 49,000 and 52,000 per week. The wire run amounted to 1,226 kilometres in 1883; 2,031 in 1884; 2,864 in 1885; 3,665 in 1886; and 4,217 in 1887.

During 1887 the new service of transmitting telegrams per telephone to and from subscribers was introduced, and although still new, has already been much appreciated; up to 1st December, 1887, in seven stations, 46,900 telegrams were transmitted by the Company. This result was obtained through the hearty co-operation of the Imperial Telegraph Officials with the Company.

This service is now beginning to pay its way, but its chief benefit is indirect, by bringing in many subscribers who otherwise would not have joined.

The charge per telegram is five kreutzers, or one penny. Compared with countries like England, France, Germany, and others, the Austrian provincial towns are few in number and have few inhabitants, and with a few exceptions are not commercial or manufacturing towns. They are situated at great distances from each other. The largest of the above is Prague, with 250,000 inhabitants, which is next to Vienna the largest town in Austria, whereas towns like Bielitz and Reichenberg have only 13,000 and 20,000 inhabitants. Considering these facts, it will be seen that the use of the telephone in Austria is quite up to the mark of any other country, and this is due to two causes: the first is the cheap price charged by the Company, varying as it does from £4. 15s. to £7 a year, and, secondly, to the great care taken to make their exchanges model exchanges both as regards line construction and apparatus.

All the lines are constructed of silicium bronze wire of 1·25mm. thickness. This wire can bear a strain of 80 to 86 kilos. per square millimetre before breaking, and has a conductivity of about 40 to 42 per cent. of pure copper.

Magneto calls are used throughout, and the apparatus are those known as the Gower-Bell and Consolidated.

The above statistics do not include those of the Vienna, Brunn and Linz Exchanges, which are worked by a different company. In Vienna there are about 1,200 subscribers, in Brunn about 250, in Linz about 180, total 1,630, which, with the total of Austria's subscribers 1,950, and private lines 72, brings up the number to 3,652. Apart from these there are a very large number of private lines in the country in those parts for which no concessions have been granted by the Government. These are almost all erected by the Government.

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PORTABLE VOLTMETERS FOR MEASURING ALTERNATING POTENTIAL DIFFERENCES.

BY W. E. AYRTON AND JOHN PERRY.

(*Concluded from page 270*)

E.—Uniformity of the Scale Divisions.

It is rather important to notice that from (9) it follows that the smaller is $\frac{s}{r} y_0$ the more uniform become the divisions of the scale.

Now, from (15), $y_0 = \frac{t^3 l_0}{4 L b q} \phi_1$; so that $\frac{s}{r} y_0$ being small means, since $s = \frac{b}{a}$, that $\frac{1}{a r} \frac{t^3 l_0}{4 L q} \phi_1$ is small, or that $\frac{t^3 l_0 \phi_1}{4 L q a r}$ is small. But as a large maximum value of the deflection is very important, and as this, as we have seen, requires that t and r should be small, and that l_0 and q should be large, the only way in which we can simultaneously satisfy both sets of conditions is to make $n q$ large—that is, by using thick wires, many wires (as many wires as possible), and very thin strips for our magnifying spring. Using thick wires, however, diminishes the range of volts that can be measured.

Finally, it is to be observed that the condition of most importance in obtaining

(1) A large maximum deflection,
(2) Uniformity of the divisions of the scale,
(3) A large range of volts that can be measured,

is to make the strip of which the magnifying spring is made *as thin as possible.*

F.—Correction for Temperature.

In what precedes we have disregarded the effect produced by the variation of the temperature of the instrument as a whole, caused partly by variations of atmospheric temperature, and partly by the warming up of the whole instrument by a prolonged maintenance of the potential difference at its terminals. We will now investigate the magnitude of the error so caused.

Let a be the coefficient of expansion of the stretched wire;

β be the coefficient of expansion of the framework supporting the ends of the wire;

y_0 be the dip OQ (Fig. 10) at the temperature of graduation;

y_t „ „ $t°$ C. above „ „ „

y „ „ $\theta + t°$ C. „ „ „ „

then

$$y_0^2 + A Q^2 = \tfrac{1}{4} l_0^2,$$

$$y_t^2 + AQ^2 (1 + \beta t)^2 = \tfrac{1}{4} l_0^2 (1 + a t)^2,$$

$$y^2 + AQ^2 (1 + \beta t)^2 = \tfrac{1}{4} l_0 \{1 + a (\theta + t)\}^2;$$

$$\therefore \quad y^2 - y_0^2 = \tfrac{1}{2} l_0^2 a \theta + \tfrac{1}{2} t (l_0^2 a - 4 AQ^2 \beta).$$

If the initial dip at the temperature of graduation be small,

$$4 AQ^2 = l_0^2, \text{ approximately};$$

$$\therefore \quad y^2 - y_0^2 = \tfrac{1}{2} l_0^2 \{a (\theta + t) - \beta t\}.$$

Let

$$a - \beta = \gamma,$$

where γ can be made positive, nought, or negative by compensation of the framework of the instrument for changes of temperature. Hence

$$y^2 - y_0^2 = \tfrac{1}{2} l_0^2 (a \theta + \gamma t) \quad . \quad . \quad . \quad . \quad (17)$$

Also, if ρ_0 be the specific resistance of the material of which the wire is made at the temperature of the framework of the instrument during graduation, and if ρ be the specific resistance when the framework of the instrument is at a temperature $t°$ C. above that of the temperature of graduation, and when the wire has a temperature $\theta°$ C. above that of the framework,

$$\rho = \rho_0 \{1 + k (\theta + t)\}.$$

Consequently, following the reasoning previously given, connecting the rate of loss of heat by radiation and convection, and the rate of production of heat by the passage of the current, we have

$$\theta = \frac{V^2 d}{4 l_0^2 \epsilon \rho \{1 + k(\theta + t)\}}, \text{ approximately.}$$

Substituting in (17) the value for y given in (6), and for θ the value just obtained, we have

$$\phi^2 + 2 \frac{s}{r} y_0 \phi = \frac{s^2}{r^2} \tfrac{1}{2} l_0^2 \left(a \frac{V^2 d}{4 l_0^2 \epsilon \rho_0 \{1 + k (\theta + t)\}} + \gamma t \right)$$

$$= \frac{s^2 d a V^2}{r^2 8 \epsilon \rho \{1 + k (\theta + t)\}} \left(1 + \frac{\gamma t}{a \theta}\right)$$

$$= \frac{A V^2}{(1 + k \theta) \left(1 + \frac{k t}{1 + k \theta}\right)} \left(1 + \frac{\gamma t}{a \theta}\right),$$

or $\phi^2 + 2 \phi_0 \phi = \frac{A V^2}{1 + k\theta} \left(1 - \frac{k t}{1 + k \theta} + \frac{\gamma t}{a \theta}\right)$, approximately (18)

Now formula (8), obtained on the assumption that the framework of the voltmeter always remained at the temperature it was at during the graduation of the instrument, may be written

$$\phi^2 + 2 \phi_0 \phi = \frac{A V^2}{1 + k \theta};$$

hence the effect of the whole instrument being heated up to $t°$ C. is to diminish the right-hand side of the equation by the fraction $\frac{k t}{1 + k \theta}$ of itself, in consequence of the increase of the resistance of the stretched wire; and to increase the right-hand side of the equation by the fraction $\frac{\gamma t}{a \theta}$ of itself, in consequence of the difference of the coefficients of expansion of the stretched wire and the framework. If γ, the difference between the coefficients of expansion of the stretched wire and of the framework, be selected so that

$$\gamma = \frac{a k \theta}{1 + k \theta},$$

then for that particular value of θ there will be no temperature error of the instrument. Now the effect of γ not being nought will be to cause a slight motion of the pointer when the whole instrument is warmed up as a whole without any potential difference being maintained at its terminals; or, in other words, γ produces what may be called a zero error. Hence the zero error can be made such that there is no temperature error when the instrument is required to measure a certain definite potential difference or a potential difference of about that value. If, on the other hand, the framework of the instrument be so constructed that γ is nought—that is, so that there is no zero error—then the deflection corresponding with any given number of volts maintained at its terminals will be somewhat diminished as the instrument warms up as a whole. In order that accurate readings may be able to be made of small potential differences giving deflections near the zero it will be desirable to make γ small, but whether it ought to be made absolutely nought or not can only be determined by practical experience of this new form of voltmeter extending over some time.

Solving (18), we have

$$\phi = -\phi_0 + \sqrt{\phi_0^2 + \frac{A V^2}{1 + k\theta} \left(1 - \frac{k t}{1 + k\theta} + \frac{\gamma t}{a\theta}\right)} \quad . \quad . \quad (19)$$

and in order to estimate the magnitude of the error arising from the terms involving t let us consider the values of the constants in the previous expression. In some of our instruments we find that the initial sag y_0 is about 0·5 centimetre, and that $y - y_0$ is about 0·22 centimetre when ϕ is about 280° —that is, when the needle is deflected to the limit of the scale. Therefore, since

$$\phi_0 = \frac{s}{r} y,$$

and

$$\phi = \frac{s}{r} (y - y_0),$$

it follows that

$$\phi = \frac{\phi_0}{2}, \text{ approximately,}$$

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when the deflection has about its maximum value. Hence, if we write X for $\frac{A V^2}{1+k\theta}$, X′ for $\frac{A V^2}{1+k\theta}\left(1 - \frac{k t}{1+k}\theta + \frac{\gamma t}{a\theta}\right)$, and ϕ' for the value of ϕ, when X becomes X′, we have

$$\phi = -2\phi + \sqrt{4\phi^2 + X}, \text{ approximately,}$$

and

$$\phi' = -2\phi' + \sqrt{4\phi'^2 + X'}, \quad \text{,,}$$

therefore the proportional error when the deflection is a maximum

$$\frac{\phi - \phi'}{\phi} = \frac{\sqrt{\frac{X}{5}} - \sqrt{\frac{X'}{5}}}{\sqrt{\frac{X}{5}}}, \quad \text{approximately,}$$

$$= 1 - \sqrt{1 - \frac{k t}{1+k\theta} + \frac{\gamma t}{a \theta}}, \quad \text{,,}$$

Now k equals 0 00031 and a about 0·0000145 for platinum-silver; also θ is about 250deg. C. when the deflection ϕ is about 280deg. Let t, the temperature through which the case of the instrument is raised above the temperature of graduation, be 50deg. C.; then, if γ be nought,

$$\frac{\phi - \phi'}{\phi} = 0{\cdot}007, \text{ approximately;}$$

that is, ϕ is diminished by about 0·7 per cent., in consequence of the increase of resistance of the stretched wire. And this temperature error can be made still less by giving γ a negative value—that is, by making the framework of the instrument have a larger coefficient of expansion than the stretched wire. For instance, if the framework which carries the stretched wire have a coefficient of expansion rather less than that of copper, the temperature error of the voltmeter in the higher parts of the scale will be practically nought.

The accuracy of the instrument depends, among other things, on the constancy of the elasticity of our magnifying springs. To test this we have had tests conducted regularly during the last two years on one of our magnifying spring ammeters. The current was measured absolutely on each occasion by the silver-deposit method, and, as this can be done more easily and accurately if the current be rather small, the ammeter selected for this series of tests was one that gave the maximum deflection (of about 270deg.) for 1½ ampere. Of course the only difference between this ammeter and a magnifying spring ammeter measuring a much larger current is in the gauge of wire used in the winding, and not at all in the spring; therefore any conclusions as to constancy that may be drawn from the results of the tests are equally applicable to any other magnifying spring ammeter. Sixty-four distinct tests have been made by different groups of students in the two years; and to impress on the students the importance of making such time tests of an ammeter, as well as to prevent their imagining that the silver-deposit test ought to give the same values for the currents as are indicated by the graduations of the scale of the ammeter, the students were warned that the ammeter had been intentionally graduated with an error—the error, in fact, being that the ammeter reads from 1½ to 2 per cent. too low.

Instead of giving the tests in the exact order in which they were taken, each group of tests is, for the convenience of comparison, arranged in chronological order.

As the tests were made by a large number of different students, having very different aptitudes for such work, some of the results arrived at were obviously wrong, and have been rejected; but, excluding these few exceptional ones, the preceding are a fair sample of the results obtained, and we see that it is impossible to conclude from them whether the ammeter has become more or less sensitive during the two years. In other words, its sensibility for practical purposes has remained quite constant. The temperature was carefully recorded after the early part of 1886, since it was thought that perhaps some temperature error might become visible; but this has not turned out to be the case, so that *the temperature may be apparently neglected in using a magnifying spring ammeter.* With a magnifying spring voltmeter wound with copper wire there will, of course, still remain the error due to a variation of the resistance of the coil with temperature; but the important result that has been arrived at is that *the indications of a magnifying spring ammeter or voltmeter, when a given current is passing through it, is not altered by age or by the ordinary changes of temperature of a room.*

Tests made with a Magnifying Spring Ammeter initially graduated from 1½ to 2 per cent. too low.

DATE.	Temperature in Degrees Centigrade.	Reading on Ammeter.	Amperes by Silver Voltameter.
6th October, 1885	...	0·588	0·592
19th July, 1886	21°	0·58	0·59
5th October, 1886	21°·8	0·58	0·596
,, ,,	17°·5	0·50	0·571
16th November, 1886	15°·8	0·5	0·514
6th October, 1885	...	0·65	0·682
14th ,, ,,	...	0·65	0·666
10th March, 1886	13°	0·600	0·615
10th ,, ,,	13°·8	0·64	0·657
10th ,, ,,	14°	0·68	0·692
21st July, ,,	22°·8	0·663	0·683
8th October, ,,	17°·5	0·620	0·635
22nd ,, ,,	17°·5	0·67	0·688
9th November, 1886	13°	0·60	0·615
6th October, 1887	18°·4	0·60	0·618
3rd August, 1885	...	0·76	0·776
6th ,, ,,	...	0·76	0·776
14th ,, ,,	...	0·757	0·775
18th November, 1885	12°	0·700	0·721
18th ,, ,,	...	0·721	0·744
9th December, ,,	8°	0·70	0·72
17th February, 1886	14°	0·700	0·727
24th ,, ,,	16°·1	0·720	0·746
23rd July, 1886	20°·5	0·722	0·749
6th October, 1887	18°·4	0·70	0·711
19th ,, ,,	16°·5	0·70	0·716
25th October, 1886	15°·6	0·84	0·859
22nd February, 1887	15°·6	0·80	0·820
5th October, ,,	16°	0·80	0·821
5th ,, ,,	16°·5	0·80	0·828
16th ,, ,,	17°·25	0·80	0·813
1st November, ,,	16°·6	0·80	0·814
1st ,, ,,	16°·6	0·84	0·861
15th February, 1887	13°·5	0·90	0·916
1st March, 1887	12°·2	0·90	0·920
8th November, 1887	18°·8	0·91	0·929
30th July, 1885	...	1·06	1·073
3rd December, 1885	...	1·008	1·022
7th ,, ,,	9°	1·07	1·096
9th ,, ,,	7°·5	1·12	1·14
14th ,, ,,	14°	1·12	1·14
27th October, 1886	14°·6	1·147	1·160

To further test this latter point a magnifying spring ammeter, adjusted so that the needle stood exactly at zero when the temperature was about 15° C., was placed in a bath and heated up to 40° C. for five hours; but no marked change in the zero could be observed, which would have been the case if the elasticity of the spring had sensibly varied, seeing that the weight of the soft iron cylinder was hanging at the end of the spring all the time. We feel, therefore, quite safe in using the magnifying springs for our new type of voltmeter.

We are now engaged in devising various means for compensating this new form of voltmeter for temperature errors; but before actually introducing these compensations into the instruments one of our students—Mr. Kilgour—has been carefully measuring the exact coefficient of expansion with temperature of fine platinum silver wire under a tension which is comparable with its breaking tension. The compensation for the short-tube form shown in Figs. 3 and 4 will probably in part consist in the device adopted by Captain Cardew of making the support to which the wires are attached of a compound metal; while in the case of our bicycle-wheel form the rim to which the wires are attached will probably be made like the balance wheel of a chronometer; but of course the same accuracy of adjustment for temperature that is necessary in a

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chronometer will be quite unnecessary in the voltmeter, as the error is not a cumulative one as it is in a chronometer.

The following, we venture to think, are the improvements that we have been led to introduce into the Cardew voltmeter by employing the devices that we have described :—

1. A small alternating potential difference can be accurately measured, as the wire in our instrument may be short, and as the readings can be taken down to zero with certainty.

2. With the same instrument a wide range of volts can be measured, since with many short wires combined with a commutator any number of them can be put in series; that is, any length of wire can be electrically used.

3. Whatever number of volts is being measured, all the wire is directly active in deflecting the pointer, which is not the case with an instument provided with an external resistance for increasing the range.

4. The instrument is compact and portable.

5. Great dead-beatness of action is secured by the employment of much finer wire than has hitherto been commercially used, and by the magnifying gearing being frictionless and comparatively massless.

6. Non-liability of even such fine wire to break from a blow, in consequence of the frictionless and comparatively massless character of the magnifying gearing to which the wire is attached.

7. Diminution in the power wasted on the instrument by the employment of a short instead of a long wire.

SAFETY FUSES FOR ELECTRIC LIGHT CIRCUITS.

BY MR. A. C. COCKBURN.

The following is an abstract of the paper by Mr. A. C. Cockburn, read before the Society of Telegraph-Engineers and Electricians on the 8th December, "On Safety Fuses for Electric Light Circuits, and on the Fusing Points of Various Metals usually Employed in their Construction." The author points out that inefficient fuses, which are often used for the sake of cheapness, are in themselves a source of danger, and gave instances of fires the origin of which had been traced to defective fuses. He insisted on the importance of using double pole fuses, viz., placing a fuse upon each of the leads. According to the author, the following are the principal conditions which should be fulfilled by a good fuse :—It should act with certainty within 5 to 10 per cent. of the current strength at which it is intended to fuse. It should not alter much with time. The contacts should be such as to allow, without dangerous heating, the passage of at least three times the maximum current which they are intended to carry. The material should not be readily oxidisable ; the wire or foil should not touch the case. The case or fuse holder should only admit the fuse specially intended for it, and should be such as can easily be fitted up by an ordinary workman. The leads should not cross. The fuse should be easily replaceable when broken. The holder should be of non-inflammable material. It should be so inexpensive that reasons of economy may not prevent its use, even for single lamps ; and, finally, the fuse should, whenever possible, be in sight, and covered only by a transparent substance, such as glass or mica. Moving parts are in general to be avoided, owing to their liability to stick ; but there is no objection to the use of electro-magnetic cut-outs on main circuits, provided they are well constructed, and proper attention is given to keep them in working order.

According to the author's experience, foil cannot be depended upon within sufficiently narrow limits of current strength, and it has the additional disadvantage of requiring to be supported throughout its length.

Prof. S. P. Thompson's fuse, in which the leads are joined by means of a button of fusible alloy, was described, and also one devised by Sir W. Thomson, in which the fuse leads consist of springs, joined by a button of fusible alloy, and which fly apart when the alloy melts. If plain wire could be depended on, it would be preferable, as the fuses could be made more cheaply. For this purpose iron is objectionable, because it oxidises readily if exposed to damp, and owing to its high fusing point it would be dangerous if used in a wooden holder which had not been made thoroughly fireproof. Copper and platinum are both open to the same objection of too high a fusing point, and copper is also found to change its fusing point after repeated heating. Lead is difficult to draw, and is very liable to damage on account of its softness, and in common with copper and iron, it oxidises very readily when heated by the current.

The metal which the author finds best is tin containing about 5 per cent. of phosphorus. It does not oxidise very readily when heated, and not at all from moisture, and it melts at 235deg. C., a temperature at which wood is not charred. Slow oxidation does take place when it is heated, and this has hitherto been the principal difficulty in the way of using simple wire fuses, as the film of oxide formed on the outer surface of the wire may retain the molten metal within it and prevent the circuit from being broken ; and though it has been attempted to remedy this by placing the wire in a vertical position, the attempt has only been partially successful. The author has got over the difficulty in a very simple manner by placing a small leaden weight on the wire, which breaks the film of oxide, as soon as the metal assumes the pasty condition through which it passes before becoming molten, and he finds that in this manner a definite fusing point, well within 10 per cent. of the current strength for which the fuse is intended to act, can be attained. An experiment was shown in which the same current was sent through two perfectly similar wires, except that one was weighted and the other not. As the current was very gradually increased, the unweighted wire attained a dull red heat, at which point the weighted wire broke without having reached redness. This experiment is very curious, as it shows that the effect of the weight is not merely to break the wire, but that with the same current the weighted wire does not attain so high a temperature as the unweighted one. It is true that the leaden weight, owing to its heat conductivity, would abstract a small quantity of heat from the centre of the wire, and owing to its electrical conductivity would slightly diminish the resistance of the small central portion of the wire in contact with it, and therefore slightly diminish the development of heat in that part ; but though these minute actions might possibly produce an appreciable effect in the part of the wire immediately adjacent to the weight, it is difficult to imagine that they could do so in the more remote portions. The fuses are made in standard lengths, and are all tested up to near their fusing point before being sent out, to ensure their not fusing for too low a current strength.

LEGAL INTELLIGENCE.

Anglo-American Telegraph Company (Limited) versus La Compagnie Francaise du Telegraphe de Paris a New York.

The following is the text of the judgment which was delivered by the Tribunal of Commerce of the Seine in this case on the 9th January, 1888 :—

The Tribunal decides :—

Whereas, to justify the rupture of the agreements which bound them to the Anglo-American Telegraph Company (Limited), the French Telegraph Company from Paris to New York puts forward a Ministerial despatch which had been addressed to them in Paris under date of the 30th December, 1886, that they allege that the existence of the relationship complained of had been subordinated to the authorisation of the French Government, and that the Minister objecting to-day to this relationship as would appear to result from the letter before-mentioned, the French Company, in repudiating the agreements, was supposed to remain under the conditions of the contract, and could not under these conditions be held responsible for any damages any more than for a resumption of this relationship ;

But seeing that it is shown by the pleadings and the documents submitted to the Tribunal that by verbal agreements entered into in May, 1882, the two companies parties to the suit had established between themselves a *modus vivendi* in the working of their cables between Europe and the United States for a period of 46 years, which should be reduced to 22 years, at the option of the parties ;

Whereas this agreement, which had for principal object to suppress the competition between the two companies, formally stipulated that the said agreement should leave intact, independent and distinct, the capital of each company, its concessions and authorisations ; that the results, good or evil, of their respective enterprises, should remain for the account of each of them, and that there should not be between them any fusion of interest, each company keeping its particular administration, its *employés*, and its special agents ;

Whereas, moreover, Article 9 of the Specification of the Concession made to the French Company recites that the Concessionary shall not make over his rights, lease his lines, nor make fusion of his interests without the consent of the French Government ;

Whereas that, although the contracting companies had come to an understanding not to make any fusion whatsoever of their interests, they stipulated, nevertheless, that their understanding should not take effect except after the Governmental authorisation,

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which might be necessary for the French Company, had been solicited and obtained, if need should arise, and that in default of ratification or of authorisation within the period fixed at sixty-five days, then prorogued to 113 days, these agreements should be considered as null and of none effect;

Whereas it is acknowledged at the Bar, and not denied by the French Company, that the latter asked for the Governmental authorisation;

Whereas it is established and recognised equally at the Bar by both parties in evidence that, in reply to this demand it was declared by the Minister that the agreement which was submitted to him, not coming within the prohibitions of Article 9 of the Specification, there was no need of any authorisation;

Whereas, the board of directors of the French Company in the report presented to the shareholders of the company at the ordinary general meeting on the 11th May, 1881, declared, on the subject of the said authorisation:

"We have assured ourselves that the Governmental authorisations are not necessary to us" . . .

Whereas, then, from that time, nothing being opposed to the execution of the agreements, the latter received their application, and that these agreements, perfectly known to the French Government, were executed more than five years without there having been raised any objection;

Whereas that, if on the 30th December, 1886, the competent Minister interpreting the agreements otherwise than his predecessor thought fit to recall the French Company to the integral carrying out of the clauses of its specification, this new and unexpected interpretation of the parties to the suit could not create, as is alleged by the French Company, a case of *vis major*, putting them under the obligation of breaking immediately their engagements;

That, in effect, Article 14 of the Specification recites:—"That if differences should be raised between the French Government on the one part and the Concessionary or the Company on the other part on the subject of the interpretation or of the carrying out of the concession, these differences shall be adjudged administratively by the Council of Prefecture of the Seine, subject to appeal to the Council of State;"

That it therefore was incumbent on the French Company to appeal to the first interpretation given by the French Government in bringing to the knowledge of the Minister in power the assurance which had been given by his predecessor, that the Convention of the 12th May, 1882, did not come within the prohibition of Article 9 of the Specification, and that there was no need of any authorisation;

That it appears to be established that the Minister was not made acquainted with this decision of his predecessor;

Whereas, for the rest, the Ministerial despatch of the 30th December, 1886, could not constitute a legal notice calling for an immediate cessation of all relationship between the co-contracting companies;

That it was incumbent at this moment on the French Company to have recourse to competent jurisdiction, to obtain the maintenance of agreements confided to them in good faith;

That in not doing this, and in interpreting as they did the Ministerial despatch of the 30th December, 1886, they permit of the supposition that they had an interest in that the verbal agreement of May, 1882, should not be executed;

That this method of acting constitutes a violation of the agreements entered into which involves their responsibility;

That there is reason under these conditions to recall them to the respect of engagements subscribed to by them, and to compel them to resume the execution of them within a certain delay and under a constraint which will be mentioned presently, and to pay to the plaintiff company by way of damages a sum which the Tribunal fixes at £80 per diem, from the 31st December, 1886, until the day of the resumption of the working, if it takes place before the signification of this present judgment; if not, then up to the date of the said signification.

For these reasons:—

The Tribunal decides "that on the day of the signification of the present judgment, the French Company, Paris to New York, must resume the execution of the agreements of the 24th September, 1880, and the 12th May, 1882, and that, until it has been absolutely adjudged by competent jurisdiction as to the value (force) of the Ministerial declaration of the 30th December, 1886, the whole at a penalty of £200 per diem of delay, during one month, after which justice will be done (upon a further application);

"Condemns the French Telegraph Company, Paris to New York, to pay to the Anglo-American Telegraph Company (Limited), by way of damages, a sum equivalent to as many £80 as there may have elapsed days from the 31st December, 1886, up to the resumption of the agreements if this has taken place before the signification of the present judgment, and if not, then up to the day of the said significatino;

"Condemns the French Telegraph Company, Paris to New York, in costs."

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Jan.* 14*th*, 1888.

I mentioned in my last letter the fact that the next meeting of the National Electric Light Association will be held at Pittsburgh. I may add now that there is a probability that the president, Mr. J. F. Morrison, will carry out his long-delayed intention of resigning that office. The association has been built up largely through Mr. Morrison's efforts, and he has given no little time and attention to its affairs. More than once before he has sought to relinquish the office, but each time he has been so earnestly requested to continue that he could do nothing else but hold on. His business engagements of late, however, have grown so numerous and pressing that he feels he must insist on carrying out his wishes in this respect. This resolve on his part is universally regretted. It is understood that Mr. Morrison's successor will probably be Mr. S. A. Duncan, of Pittsburgh. Mr. Duncan is one of the young men who have come to the front in electrical enterprises in this country by their industry and ability, and he is to-day identified very prominently with lighting and motor interests in the city above named. It is interesting and suggestive that, like Mr. Morrison, he is an old telegrapher, and was induced to leave the more familiar field by the promises held out in the new, which has been so fruitful of good results for men of the right stamp. The importance of the position in the eyes of the public may be inferred when I state that recent estimates show the existence in this country of 1,000 central stations and 3,000 isolated plants, arc or incandescent, or both.

These plants have a capacity in the neighbourhood of 200,000 arc lights, and a million and a-quarter incandescents, and operate a great many motors as well. Where an industry is susceptible of so many changes and developments, it is very difficult to get at the closest figures with regard to it, but the statistics just given are a safe approximation to the actuality.

As a matter of personal gossip, in this connection it may not be out of place to say that Mr. Morrison is not simply a successful executive officer or a mere business man of push and enterprise. At his home in Baltimore are to be found excellent specimens of the work of our best American painters; some of them purchased when those artists did not enjoy the vogue they now have; but the most interesting thing there to electricians is his fine electrical library, which is rich in old and rare editions, and includes every one of the electrical books issued in recent times. It is also noticeable as containing complete files of technical journals and publications, which are extremely difficult now to duplicate. On this library Mr. Morrison has spent many thousand dollars, and it is steadily growing. There are not very many such private collections in this country of electrical literature. Prof. Alexander Graham Bell probably possesses by far the largest and the best. Mr. Edison has a magnificent library of scientific books, which for some months past has been slowly getting into order at Orange. Mr. Edward Weston has also a remarkably fine and choice collection, including such famous first books as Gilbert and Volta. Perhaps the choicest, though not the largest, collection of rare electrical books in America is that of Dr. Park Benjamin, the well-known expert, and the author of the popoular "Age of Electricity," and numerous magazine articles, &c. It is said that this collection embraces works that were not included even in the well-known Latimer Clark library. It is certainly one of great value, the possession of which every bibliophile must greatly envy Dr. Benjamin, who, it is to be hoped, will some day put forth the results of his long and patient researches in this field. Early electrical literature is to-day little read or understood, and a master hand is required to sweep away the blunders, and misstatements, and misconceptions that have buried the work of the old worthies, or upon which have been built up unstable reputations.

A small sensation was caused here this week by the announcement in some of the daily papers of New England that tele-

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phone counsel had been summoned to Washington by the Supreme Court. This, of course, was interpreted to mean that the Supreme Court intended to hand down its anxiously-awaited decision in the telephone cases. The fact was, however, that no such summons had been sent out, and that no decision was given out; and so we must possess our souls in patience a little longer. An important opinion with regard to telephones has, nevertheless, been given recently by a Western Court, which held that under the law of the State the telephone company was bound to furnish every applicant with a telephone and proper connections at the statutory rate. The company objected on the ground that it was doing merely a toll line business, into which such legislation had, in fact, forced it; but the Court did not admit the validity of this plea. In New York some consolation is derived from the understanding that the Legislative Telephonic Investigating Committee will present a comparatively mild report. It was stated before the committee that you had better telephone service in London than we have here. We are hardly inclined to believe this, and it is not thought that the committee will take such a view of the case, nor that it will report very severely as regards the rates charged.

Some idea of the extent to which electric lighting is being pushed in this country may be formed from the fact that the new premises in which the Consolidated Electric Light Company will carry on the manufacture of the Sawyer-Man lamp in this city covers thirteen city lots. It is a six-story building with a frontage of 325ft., and has a floor space of 117,000 square feet ready for use. This is, it would seem, the largest incandescent factory in the world, and it certainly will be without rival if it manufactures, as is claimed to be the intention, from five to ten thousand lamps per day. When it is borne in mind that other lamp producers are manufacturing on a more extensive scale than ever, it will be seen that the promoters of electric light enterprises face the future with equanimity. This, in spite of the fact that innumerable new systems of making and burning gas are being sprung upon the public. We have had all sorts of crazes of this kind here, including the Welsbach, which seems to have run its course, though while it was at its height scores of companies with millions of capital were organised in all parts of the Union. There is no doubt, however, that improvements will be made here in the direction of the greater use of fuel gas, and it may be noted that Mr. C. M. Lungren, C.E., is introducing a system of the Welsbach character, but superior in many respects, and using an incandescent spiral of unusual cheapness and longevity. Mr. Lungren claims great economy for his system over electric lighting and other forms of illumination, and as a number of shrewd men prominently identified with telephone interests have given him a certain amount of support, it would seem that he has something really meritorious; but it is not at all apprehended that electric lighting interests will suffer from the introduction of this or any other method of utilising fuel gas for light at the place of consumption. On the contrary, the belief is growing that we shall see no small development in the way of utilising fuel gas to drive gas engines, in their turn operating dynamos for electric light and power.

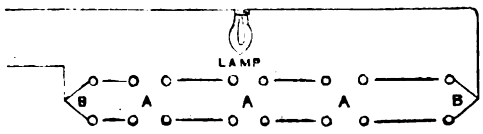
Already an extensive use is being found for the storage battery in central station plant. This has been especially the case in Pennsylvania, where plants of this kind are now to be found at Allentown, Bethlehem, York, and Reading, and where new installations are contracted for in Philadelphia and Harrisburg. It is not altogether to be expected, however, that work of this kind would be attempted in the furthest removes of the Far West; but it is worthy of note that a plant has just been put in at Burrtown, one of the newest towns in Kansas. As one of the local journals says:—"Burrtown, although one of the smallest cities in the world, is by no means behind others of larger proportions in the great race for progress. This assertion can be readily bolstered up by numberless arguments, the chief one of which is the fact that an electric light system, the equal of which can be found in several Eastern cities, but its superior in none, has been established and put in operation within the past few weeks. At the present time Burrtown is being talked of more perhaps than any city in the country." I am glad to lend my help in securing for Burrtown this proud distinction and wide-spread publicity, and, after all, the embryo Kansas settlement deserves commendation for its enterprise. The plant in question uses the well-known batteries of the E.P.S. type, made here by the Electrical Accumulator Company. In Kansas City, also, considerable use is being made of storage batteries for lighting, and it is not at all unlikely that several other plants in the State will soon follow this example.

CORRESPONDENCE.

INDEPENDENT SWITCHES FOR ONE LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to point out to you that the method of controlling a lamp or group of lamps from either one of two points, which you described in your last issue, may be increased to control them from any number of independent points in the following manner:—



The switches at B B are plain two-way switches, but the intermediate switches at A are reversing switches. It will be seen that reversing any one of the switches will light the lamp if it be extinguished, or extinguish it if it be lighted. If some of our electric light fitting makers would give a little attention to cheap and compact two-way and reversing switches such a plan as this might be adopted with advantage in many places where people would hesitate long before using an electromagnetic switch.—Yours, &c., R. H. C. NEVILE.

Wellingore Hall, Grantham, Jan. 23, 1888.

PRESERVATION OF OVERHEAD WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I invite Mr. Bozon to state in your columns the weight of his india rubber compensator, which, as he says, yields ¼in. per ½cwt. stress. My steel springs, if yielding only ¼in. per ½cwt., would weigh barely 1½ *ounce* per span. Such a slow rate of yield would be practically useless.

A copper wire of 100 yards span needs a relief not of ¼in. but of nearly 4in. per ½cwt. stress per span to save it from storm stresses. My double steel springs, therefore, weigh nearly 1½lb. I think Mr. Bozon will find it necessary to *multiply by 16* the weight of his india rubber. And this at 4s. per lb. must make it much too costly, as well as too heavy, to say nothing of its liability to decay.

I cannot see that Mr. Bozon's arrangement prevents (as mine does) the destruction of the line wire by chafing at its attachments; nor can I see that Mr. Bozon would improve insulation, &c., by cutting the wire at each post, and passing the current through the compensator itself; while my spring shackle preserves continuity of line wire and greatly improves insulation.

Further, it does not seem to have been Mr. Bozon's object to utilise the form of insulator in most approved use. I have utilised it, though my spring shackle is suited to other forms of insulator also.

Although I regard Mr. Bozon's application of india rubber as utterly impracticable, I may add that he cannot use it as he proposes without infringing my patent rights.

I take this opportunity of inviting public attention to the fact that no writer has yet succeeded in sustaining one objec-

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tion to my spring shackles. It cannot be denied that they would greatly prolong the life of the wires, while improving the insulation and preventing interruption. And if spring shackles are employed, silicon bronze wire for long spans need not be substituted for copper wire. Moreover, for over-house and over-street long spans spring shackles would obviate the necessity for such an extension of Parliamentary powers as is now meditated by telephone companies.—Yours, &c.,

Sunderland, January 21, 1888. FRANK CAWS.

"HANDBUCH DER ELEKTRICITAT UND DES MAGNETISMUS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have noticed that in your review of the lately published "Handbook of Electricity and Magnetism," by Dr. O. Frölich, on p. 12 of the current volume of *The Electrician*, you specify the same as the 2nd edition of the 2nd Vol. of my "Handbook of Telegraphy."

An authority for this statement may have been found in the text of the preface to the first-mentioned work.

Will you allow me, therefore, to draw your attention to the fact that this new book does not form a part of my "Handbook of Electric Telegraphy," and as you may now see by the revised preface, which I enclose, wherein the passage in question, on my request, has been put into a different form for the sake of preventing any misunderstanding.—Yours, &c.,

Dresden, Dec. 19, 1887. E. ZETZSCHE.

[Dr. O. Frölich, referring to this matter in the new preface (a copy of which Dr. Zetzsche encloses in his letter), says:—

"The above preface appeared in the second volume of Prof. Zetzsche's 'Handbook of Telegraphy,' written by me in 1878.

"This present 'Handbook of Electricity and Magnetism' is only connected with the first-mentioned work so far as the points of view, the arrangement of the material, and the manner of treatment are concerned. But the book is intended for a larger circle of readers, and contains, therefore, essentially different and additional matter, especially with regard to the technical portion of the subject."]

ELECTRICITY AND DOCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your Notes of to-day you venture to criticise a paper by Dr. C. B. Radcliffe "On the Electrical Basis of Vital Motion," in which he does not appear satisfied with the electricity generated in the organic system, but must seek "an electrical action extending to the whole solar system and not limited to it."

If you will turn to *The Electrician*, Vol. IV., you will find a review of Dr. Radcliffe's course of lectures on "certain disorders of the brain," &c., in which he then appeared satisfied with the electricity found in the system as accounting for all muscular energy, &c. That Dr. Radcliffe was searching in the right direction was confirmed by Continental electro-physiologists and by the interesting experiments of Dr. Shettle. He must now, however, throw up a cloud of nebulous matter collected from space to account for the electrical basis of vital motion, to conceal his inability to explain it. As your journal has become the organ of the electrical engineer and not the electrician, I will not ask *your* readers to wade through Vols. IV. and V.; but should any electro-physiologist care to study the subject he will find ample information contained therein to elucidate this question. In brief, my lectures were written to demonstrate chiefly the generation of nerve force in the capillaries, the result of the electric tension existing (proved) between the arterial and venous blood.—Yours, &c., HARRY LOBB.

66, Russell-square, January 20th, 1888.

[We have received, too late for insertion in this issue, a letter from Mr. J. M. V. Money-Kent on the same subject.—ED. *E.*]

THE TELEGRAPHISTS' SCHOOL OF SCIENCE, ST. MARTIN'S-LE-GRAND.

The eleventh annual prize distribution of this school took place on Friday, the 13th inst., in the Postmaster-General's Deputation Room, Mr. H. C. Fischer (Controller of the Central Telegraph Office) in the chair, supported by Mr. C. H. B. Patey, C.B. (Secretary to the General Post Office), Mr. W. H. Preece, F.R.S. (Electrician), and several chief officers of the department, including Messrs. Lamb, Ardron, Macgregor, Ogilvie, Hookey, May, Barlow, and J. T. Hill.

In the report, read by the SECRETARY of the School, it was shown that great success had attended the teaching of Mr. Slingo and his assistants Messrs. Miles and Brooker. Nineteen out of 25 candidates in magnetism and electricity, and 5 out of 6 candidates in mathematics, were successful; 15 sat for examination in telegraphy under the City and Guilds of London Institute: 2 failed and 13 were successful, 10 of them taking first class certificates. Mr. F. Tandy, a promising young student, gained the first prize in the United Kingdom, viz., a silver medal and £5, with a first class honours certificate. He also took first class certificates in electricity and mathematics. Thirty-five local prizes of considerable value were also awarded, the three principal being aggregate prizes for general success. The first, value £2, was awarded to Mr. F. Tandy; the second, £1. 1s., to Mr. J. Bailey, and the third to Mr. W. J. Callow. The report drew attention to the fact that in telegraphy 13 out of 73 certificates in the United Kingdom were gained by members of the school; also, that as twenty-four schools were represented, the average success was only three certificates per school, as against the above-mentioned thirteen. During the twelve years that the school has been in existence, 353 members of the staff have passed through the classes, and have gained considerably over 400 certificates. During the past four years five medals out of twenty-six awarded for telegraphy in the kingdom have been gained by the school.

Mr. PREECE, in distributing the prizes, congratulated the school on its success, and on having Mr. Slingo for its teacher, and impressed upon his hearers the great advantage of technical education and the necessity and advisability of continuing the studies so well commenced. He laid particular stress upon the need for continued study and application at home, and believed that the real duty of a teacher was to direct the studies and regulate the thinking power of his pupils. It was the student's duty to inquire fully into every detail, and never to believe an experiment until he had performed it himself.

In responding to a vote of thanks Mr. PREECE said he hoped an opportunity would soon offer itself for increasing the work and efficiency of the school, and Mr. PATEY, in responding for the department, said no effort would be spared to ensure the continued success of the classes, and hoped that the time would soon come when the work would be so heavy that it would be necessary for Mr. Slingo to devote his whole time to the interests of the school.

A hearty vote of thanks was accorded to the Chairman, who said in response that he had noticed with pleasure the gradual and sturdy growth of the school, and promised that every facility should be afforded to members of the staff joining the classes.

BOOKS RECEIVED.

"Practical Physics for Schools;" Vol. I., "Electricity and Magnetism." By Prof. BALFOUR STEWART and Mr. HALDANE GEE. (London: Macmillan and Co.)

"Papers of Fleeming Jenkin, with a memoir by Mr. R. L. Stevenson." 2 vols. (London: Longmans and Co.)

"Turning Lathes: a Manual for Technical Schools and Apprentices." Edited by J. LUKIN, B.A. (London: E. and F. Spon.)

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

549. J. BLACKBURN. London. Improvements in dynamo-electric generators and motors. January 13, 1888.

584. W. L. MADGEN. London. Improvements in the method of and apparatus for supplying electric railways or tramways with electricity. January 13, 1888.

609. A. BERGHAUSEN. Berlin, Germany. Improvements in apparatus for determining the poles of electrical circuits and generators of electricity. January 14, 1888.

623. R. J. GULCHER and the firm of JULIUS PINTSCH. London. Improvements in thermo-electric elements and piles. January 14 1888.

633. C. COERPER. London. Improvements in dynamo-electric machines. January 14, 1888.

664. F. J. LOVETT. London. An electrical lamp for bicycles, tricycles, and other carriages. January 16, 1888.

698. R. CORNTHWAITE. Bradford. An improved holder and switch for electric lamps. January 17, 1888.

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713. THEOPHILUS COAD. Forest Gate. Improvements in voltaic or galvanic batteries. January 17, 1888.
718. E. GUITTON. London. Improvements in self-acting electric batteries or generators in which the liquids are automatically renewed (M. Sappey, France). January 17, 1888.
727. R. KENNEDY. Glasgow. Improvements in thermo-dynamo electric machines. January 17, 1888.
729. D. URQUHART. London. Improvements in electric batteries and elements therefor. January 17, 1888.
734. J. NOAD. London. Improvements in galvanic batteries. January 17, 1888.
742. L. A. GROTH. London. Improved apparatus for tanning hides and skins by the aid of electricity. January 17, 1888.
750. H. H. LAKE. London. Improvements in and relating to electric railways and to vehicles for use thereon (D. G. Weems, United States). January 17, 1888.
789. J. A. KINGDON. London. Improvements in the construction and application of transformers for the distribution of electricity for lighting and other purposes. January 18, 1888.
791. R. A. SCOTT. London. Improvements in junction boxes for electric conductors. January 18, 1888.
804. M. PULVERMANN. London. Improvements in electric clocks (C. Bohmeyer, Germany). January 18, 1888.
873. L. HEN and R. WEINMANN. London. Electric igniting apparatus. January 19, 1888.
874. F. H. JUDSON and W. J. WOODWARD. Southwark. Improvements relating to the repair of electric incandescent lamps. January 19, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

January 21, 1888.

563. H. H. LEIGH. London. An improved dynamo electric machine (J. L. Clerc, France). January 13, 1887.
701. S. ZIANI DE FERRANTI. London. Improvements in electrical meters. January 15, 1887.
702. S. ZIANI DE FERRANTI. London. Improvements in dynamo electrical machines. January 15, 1887.
717. W. B. SAYERS. London. Disc dynamo electric machines and motors. January 17, 1887.
800. J. B. WILLIS. London. Improvements in electric telegraph apparatus suitable for use to communicate between the bridge and the engine room of a steamship, and applicable also to other uses. January 18, 1887.
831. M. IMMISCH. London. Apparatus for converting alternating currents into continuous ones. January 19, 1887.
2,959. H. C. CHOCQUEEL. London. A new or improved combined bell-push and automatic switch for electrical alarms. February 25, 1887.
3,878. H. BOARDMAN. Bradford. Improvements in or connected with electric alarm clocks. March 15, 1887.
3,943. W. H. DOUGLAS. Birmingham. Improved instruments for measuring electric currents. March 16, 1887.
4,138. A. C. COCKBURN. Canonbury. Improvements in safety devices in electric circuits. March 19, 1887.
8,329. W. E. LANGDON. Derby. Improvements in electrical signalling apparatus for railways. June 10, 1887.
11,923. C. L. R. E. MENGES. London. Improvements relating to the manufacture of plates or electrodes for primary or secondary electric batteries and to apparatus therefor. Received September 2, 1887. Ante-dated February 19, 1887, under international convention.
14,768. C. M. DORMAN and R A. SMITH. Manchester. Improvements in the construction of switches for the making and breaking of circuits conveying electric currents. October 31, 1887.
16,351. A. OWEN. London. Improvements in electric belts. November 28, 1887.
16,376. C. B. NOBLE and R. D. NOBLE. London. Improvements in electric arc lamps. November 29, 1887.
17,157. H. H. LAKE. London. Improvements in galvanic batteries (J. O. Whitten, United States). December 13, 1887.

PATENTS SEALED.

January 13, 1888.

395. C. ZIPERNOWSKI, MAX DERI and O. T. BLATHY. Budapest, Austria. Improvements in induction coils or transformers. January 10, 1887.
9,729. W. P. THOMPSON. Liverpool. Improvements in or relating to electric converters (G. Westinghouse, jun., United States). July 12, 1887.

January 17, 1888.

114. W. A. LEIPNER. Bristol. An improvement in dynamo-electric and electro-magnetic machines. January 4, 1887.
13,092. W. R. LAKE. London. Improvements in and relating to the manufacture of materials for the production of carbon filaments for incandescent electric lamps and other articles (La Société A. Cruto & Cie, Italy.) September 27, 1887.
13,454. R. T. TURNBULL. London. Improvements in fittings for incandescent electric lamps. October 5, 1887.
13,722. C. E. PONDER, J. MACGREGOR and P. HARRIS. Sydney, New South Wales. An improvement in electrical secondary batteries. October 10, 1887.
13,736. A. S. KIMBALL and G. L. BROWNELL. Massachusetts, United States. Improvements in electric spinning and twisting machines. October 11, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

12,032, 1886.—A. FEATHERSTONHAUGH. Electric incandescent lamps. (Price 8d.)
16,650, 1886.—O. SKRIVAN and F. DVORÁK. Electric apparatus for the control of watchmen. (Price 8d.)
16,661, 1886.—R. P. SELLON and OTHERS.—Self-regulating dynamo-electric generators. (Price 8d.)
266, 1887.—E. EDWARDS. Electric telegraphs. (Price 1s. 8d.)

COMPANIES' MEETINGS.

The Eastern Telegraph Company (Limited).

The thirty-first half-yearly ordinary general meeting of the Eastern Telegraph Company (Limited) was held on Thursday, January 19th, at Winchester House, Old Broad-street, London, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY read the notice convening the meeting, and the minutes of the thirtieth half-yearly ordinary general meeting of the shareholders, held on the 14th of July, 1887, which were signed by the Chairman; and the report having been at the request of the meeting taken as read,

The CHAIRMAN said: I will now, as usual, make a few remarks so as to supplement the report, and give you such information as we think it desirable that you should have. The revenue for the half year ended September, 1887, amounted to £291,265, as against £292,229 in the corresponding half year of 1886, being a decrease of £964. The Directors, however, consider that this is satisfactory, because the decrease of revenue caused by the reduction of tariff to India has sensibly diminished, and indeed the improved traffic with Australia, China, and other countries in the far East has more than recouped the loss in Indian messages. Our traffic with Egypt, on the other hand, shows another falling off; but this has been made good by an increase of messages exchanged with Portugal and South America. Having so many points for the interchange of traffic, we find sometimes that the loss made in one direction is at other times made up by the increase in other directions. For the current half year our prospects are favourable. Our traffic now shows a small increase every month, and it is hoped that next July, when we present the accounts for our financial year to the 31st of March, we shall be able to give the shareholders a bonus in addition to the 5 per cent. dividend. The total working expenses amounted to £79,936, against £81,021, or a decrease of £1,085. With the exception of the expenses of redemption of 5 per cent. debentures and the issue of 4 per cent. stock, £912, we have had no expenses of an exceptional nature, such as, for instance, are inevitable in time of war. The general expenses in London were £8,012, against £7,964 in 1886. Some of the items under this head are more and some less, the net difference being a small increase of £48. The expenses at stations were £56,386, against £58,129, or a decrease of £1,743. The principal reduction, however, is in repairs and renewals of cables, which this half year amounted to £34,102, against, in the same period of 1886, £53,965, or a decrease of £19,863 upon the half year. Therefore, after charging all the expenses, including income-tax, providing for interest on debentures, debenture stock, and preference shares, we are able to pay an interim dividend on the ordinary shares at the rate of 5 per cent. per annum, and to carry forward to next half year a balance of £29,397, or £16,306 more than at the same period of 1886. Gentlemen, before asking you to approve of the report, I shall supplement the statement which I have just put before you by a few words of explanation and encouragement. In the speech I made six months ago I referred very fully to the position of the Company, not only at the moment, but as to its prospects, and as to the work it had before it. I referred then to the loss of income that was forced on us at the Berlin Conference. That loss caused for a time the suspension of our bonus, because it practically took away the amount we required to pay the bonus. However, last half year, if you remember, we announced at the close of the half year a bonus of ½ per cent. I also told you then that the bonus, we had decided, should, as a rule, be dealt with once a year. I have shown you to-day that we are carrying forward a very considerable sum, but until we close the year there is always an amount of uncertainty that what may be a large sum to carry forward to-day apparently may be materially reduced by serious interruptions to our

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cables. I may tell you that our ships are constantly employed in making repairs, and though our costs for that during last half year were £19,000 less than in the corresponding period of the previous year, still our ships are constantly employed; but, as I have said before, while we can repair, it proves the value and solidity of our property. I am hopeful that, as we improve more or less the quality of our cable which we put into the sea, we shall lessen those repairs. If we could be free from those repairs I need not tell you that we should be able to pay you very handsome dividends. I referred also to our having just completed our Tangiers cable. That cable was laid by us, and was supposed to have been laid, by some of the Powers probably, without consulting sufficiently the Sultan of Morocco. However, the cable was a necessity. We accepted the position of laying the cable, and it is working now, and not only benefiting the Sultan's dominions, but also materially helping the Company. We have therefore done a good work, and probably, having shown a little energy in carrying it through, we have done so to the satisfaction of all parties, and there is no chance now of the Tangiers cable being disturbed. I also referred to the difficulties we had at that time with the French Government with respect to the renewal of our wire through France. That has always been useful as a stand-by, but for reasons which I cannot well explain (and it is difficult to do so, because we put a good deal of money into the French exchequer for that wire) we cannot yet get a renewal of it, and that line, the concession for which expires next year, we have not yet been able to get renewed. We have, however, as I have told you before, decided to make ourselves thoroughly independent, and we have laid a fresh cable from Porthcurno to Lisbon, Gibraltar, Malta, and Zante. I stated at the last meeting that when this cable was laid we should be able to give a good account of it by showing how we were going to recoup ourselves by savings in other quarters. The new cable has done its work in the most satisfactory way, aiding us in carrying our traffic more satisfactorily, and placing us in a perfectly independent position if war should break out on the Continent to-morrow. In these days of scares I think it is the duty, and it has always been our policy, to be ahead of the requirements both of the Government and of the telegraphing public. Thanks to the policy of the Company in duplicating our system, our system is now almost entirely duplicated, and triplicated as far as Aden. Had we depended on one wire, with the interruptions that constantly take place, and the employment of our steamers from day to day in effecting repairs, it would have been most unsatisfactory in every sense. It would have interfered with your dividends, it would have interfered with the telegraphing public, and it would have thrown discredit on the whole telegraphing system. We have entirely got the better of that by duplicating, and in some cases by triplicating our system. There are breakages now that the public know nothing about. We carry the traffic just as well as if every yard of our cable were in good condition. But you see in the accounts considerable expense connected with the repairs which we have had to make. Still, they do not interfere with the telegraphing public, or with you and your dividend. Therefore, I think you will admit that the policy of the Company in securing a continuous system is the only policy which can ever make submarine telegraphy prosperous and great. It has become great, and your Directors are determined, in future as in the past, to maintain that continuity, so as never to allow it to be said at any time that our system is not operative.

I referred at the last meeting to the improvement generally in trade, and I said that the telegraph was a great barometer of trade. I am glad to say that trade is still improving with our Colonies, as is evidenced by our having recouped the amount of money which we were obliged to give up in the reduction of tariffs at the Berlin Conference. That state of things brings us into the position, as I have said, at the end of the year, not only to pay you a dividend, but I hope a bonus, probably of 1 per cent. If we get back to the old 1 per cent. it would be satisfactory for a time, but we shall be able to show you distinctly from the figures whether we can pay you more or less. If we can give you more we shall always do what we conceive would be appreciated by our shareholders. You may say, "Why do you not pay us a bonus to-day?" (hear, hear). Well, that is quite a proper view, but we have to look a little ahead. There is a great deal of excitement in trade, more or less, particularly in Africa, where we hear about gold and diamonds, and if we were to believe all that we read about of these things we should have such a traffic, and there would be such an extension of trade, that it would place us in a very satisfactory position indeed. We are not quite disposed to be led away by these very sanguine views. We believe that gold is to be found in quantities in South Africa, and we know what gold discoveries have done for California. I hope they will do the same for South Africa if it is found in the same quantities there. The trade of this country very much needs it, South Africa wants it, and this Company needs it also very much in increased dividends. Six months hence we shall know something more as to whether this "boom" has sprung up on a strong foundation. If so we shall be able to pay you a dividend and a bonus corresponding.

There is another question that will, I think, be very satisfactory to you, as showing you the position this Company holds in the estimation of the commercial mind of London. We have replaced £450,000 of our Five per Cent. Debentures with Four per Cent. Debenture Stock. We first issued our Four per Cent. Debenture Stock at £95. When we made the exchange the other day we were able to get a small premium on the par value, showing that a Four per Cent. Debenture Stock of ours is considered a sound investment in the City of London. One gentleman I met lately, an eminent accountant and a Member of Parliament, said that nothing had struck him more in connection with the submarine telegraph system than the successful issue of our Four per Cent. Debenture Stock. I hope that that credit will continue. At all events, the policy of the Board will be to maintain the credit and efficiency of the Company.

There is another point that I think it well to give you some little information upon—that is, our reserve fund. I want to show you how we have kept down our capital, how we have applied the reserve fund in a good many instances to giving security to our dividends. If we had kept our reserve fund intact, and laid our new cables out of capital, we should have added close upon half a million to our capital. Instead of that we have drawn from the reserve fund from time to time, and at the same time taken from our annual income, and have thus built up all this duplicate and triplicate system from our income and reserve funds. If all the money we had put to the reserve fund had remained in the reserve fund to-day, that fund, instead of being what it is, would have amounted to over one million sterling. Now I think you will approve of that policy. It is a bad thing to overburden any system with capital, and as long as we can pay a satisfactory dividend, and secure that dividend by additional cables, I think it is the best policy for us, and it is the best for the shareholders also. It might please the shareholders to have an extra one or two per cent. to-day, but our policy is to place this Company in such a position that people will look with some certainty to their 5 per cent., and, when good times come, to a bonus corresponding to the success of the Company. I think I might mention the large sums that we have taken out of our reserve fund. We took to duplicate the Red Sea and Indian Ocean cables £100,000; we took to triplicate the Red Sea and other cables £300,000, we took for the Sicily and other cables, &c., £34,803. Altogether, therefore; we have taken out of the reserve fund something like half a million to consolidate and strengthen our position. With these remarks I think I have pretty well finished the information that I desire to give you. I think I may fairly end my observations by congratulating you on the prosperous condition of the Company at the present moment—prosperous because it is built on a sound foundation—and, I think, from that foundation we shall from time to time be able to show you that the superstructure is sound. With these remarks I beg to move:—

"*That the report and accounts of the Directors to the 30th of September, 1887, submitted to this meeting, be and the same are hereby received and adopted.*"

The VICE-CHAIRMAN (the Marquis of Tweeddale): I beg to second that.

The CHAIRMAN: If any shareholder desires to put any questions I shall be very glad to hear them.

Mr. LINDSAY NICHOLSON: I think we may well congratulate you, sir, on the results of the past half year's working. I think it looks as if the depression culminated last year; and with the revival of trade, with the improvement in metals, and the revival in the shipping interest, we have, I think, every prospect of having good returns in the present year. Let us hope that the past was the worst. When you proceed to reply to the questions, I should like to ask you, as one interested in the matter, whether there is a prospect of the cable being duplicated to the Philippines—a very important Spanish possession. I would ask you to make a memorandum for reply later on. Having said that, I should like to make a few remarks rather personal to you, Sir John Pender, than otherwise. I believe every shareholder in this room will join with me in cordially congratulating you upon the honours that have been conferred upon you (cheers). The electric telegraph and electricity are supposed to annihilate time and space, but we cannot forget that for more than 30 years you have, wherever the telegraph or electricity is concerned, been well to the front. It is for that reason, I am sure, that I shall be expressing the feeling of those in this room in cordially congratulating you. Though so much has been said about the Colonies and federation, I know nothing more calculated to encourage that federation than those little cables which we see connecting the mother country with all the countries of the world. At a time when all the Jubilee honours were being lavishly given away, I am confident that many of the shareholders of the Company would have felt no surprise if the highest honours had been conferred upon their Chairman, and I can only express a hope—and I am sure I express it in the name of the shareholders—that your present honours are but an instalment of future ones, and that you may long live to preside over this great Company, which you and your colleagues have done so much to benefit. I should like, in conclusion, to say that I will propose, as a rider to the report being received and adopted, the following words:—

"*And the shareholders of the Eastern Telegraph Company tender to Sir John Pender, K.C.M.G., their cordial congratulations on the recent honours conferred on him by Her Majesty as some recognition of his services to Imperial and Colonial interests.*"

Dr. WALLER: Sir John Pender and Gentlemen—A very pleasing and a very gratifying duty devolves upon me, and that is to second the very admirable observations made by the gentleman who has so well discharged the duty of expressing all our feelings of pleasure at the honours conferred on you. Talking of honours, I believe it confers no greater honour on you in the public estimation than you already enjoyed; but of one thing I am perfectly certain—that it in no way raises the estimation in which you are held by the shareholders of this Company, whose interests you have ever attended to with unwearying, unceasing vigilance and intelligence. We all owe you a great debt. I am an old shareholder, and remember many years of this Company, and I am able to say, what I am sure every one who hears me will concur in, that much of the prosperity of the Company is due to your great intelligence and industry. Sir, I will take leave to say this—that in the cordial wish that was made, that you may long live to enjoy the honours that have been conferred upon you, I beg to acquiesce most earnestly, and if it is the pleasure of those who know what merit is and how to reward it to give you still greater honours, believe me there are none who will more cordially rejoice than the shareholders of the Eastern Company.

The motion, on being put to the meeting, was carried unanimously.

The CHAIRMAN: Now, gentlemen, I can return you my most warm and hearty thanks, and let me assure you of this, that much as I appreciate the honour which has been conferred upon me by the Queen, I may say I appreciate more the honour which you do me in showing, not only now, but in

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long years past, the most perfect confidence in me as your Chairman. Were I to go back, and give you a history of submarine telegraphy, I should require to introduce a great many names—of men you see sitting at this table, who have been associated with me. I have been more or less their mouthpiece, but their minds have always been at my disposal whenever great judgment was required. I will, however, mention one name, and I think I may do that because it is so closely connected with telegraphy in its infancy. When the first cable was laid—and that is a great many years ago—there was an impression that a cable once laid was parted with for ever. My friend Sir James Anderson proved that a cable even at 2,000 fathoms depth could be repaired. From that day I said, "There is a grand future for submarine telegraphy. If we can repair the cables, there is no doubt whatever of the vast extension of this system. It will probably federalise the world in a way which no other system would ever do." I think up to this point that all these anticipations have been realised. The working of this great system is in comparatively a few hands; but the hands which began it, nearly all of them, are working to-day—at least, those who formed what was called the combination over which for some years I have presided. I now return thanks for the honour you have done me, and I can only say that I could have done little unless I had had the support, not only of my colleagues, but of the generous body of shareholders who have stood by this Company during all these long years. Now, let us come to business. Mr. Nicholson asked about the Philippine Islands. The Extension Company, of which I am president, is now in negotiation with the Spanish Government on that matter. Probably that question should be put at the meeting of the Extension Company, but I am Chairman of both companies, and I can reply to-day. We are now negotiating with the Spaniards. The Spaniards are very much bitten with telegraph extensions. They are making some proposals that would startle even Sir James Anderson. But we never throw cold water on any Government in connection with any telegraph scheme if we think it can be done with practical results. With regard to the question you have put to me I hope before long you will see it realised.

The Marquis of Tweeddale: I have the honour to move a resolution which I am sure you will all accept with pleasure. It is

"*That Sir John Pender, who now retires, be and he is hereby re-elected a Director of the Company.*"

Mr. W. Ford: It is usual on these occasions, I believe, for the election or re-election of a Director to emanate from that side of the table; but on this occasion I must deprive the gentleman on that side of the table who intended to second the resolution of the monopoly that the Board would otherwise have in connection with this proposal. The gentleman who proposed the rider to the first resolution did so in such excellent terms, so fully representative of the feelings of the shareholders, not only those present but those absent, that it is really unnecessary for me to add any words of my own. Indeed, I should be very sorry by any remarks of mine to weaken the very favourable impression created by that gentleman's observations and by those of the gentleman who followed. At the same time I do wish to mark the appreciation of the shareholders' opinion of Sir John Pender's services by the proposal now before the meeting coming from this side of the table. Gentlemen, there is probably no one in this room who has had greater experience of the ability of Sir John Pender as Chairman of this Company than I. Both on this side of the table and that I have had many opportunities of judging of his capacities and of his faithfulness to the interests of the shareholders, and I do most cordially second the wish expressed by the honourable gentlemen who have already spoken that Sir John Pender may long live to preside over the destinies of this Company, feeling that as long as he does so no effort will be wanting on his part to do the best he possibly can for us. I have great pleasure in seconding this resolution.

The Marquis of Tweeddale: You have heard the resolution, gentlemen. Those in favour will please signify the same in the usual manner. To the contrary. Carried unanimously.

The Chairman: Gentlemen, I sincerely thank you for the honour you have done me in re-electing me to my seat at the Board. It has been the hobby of my life so far, and I believe it will in the future be my hobby to serve you honestly and well. I thank you for the honour you have done me. I now beg to move—

"*That the Marquis of Tweeddale, who now retires, be and he is hereby re-elected a Director of the Company.*"

The Marquis of Tweeddale's name is so well known that I need not say one word about this motion, except that he has been from the beginning an earnest and honest worker and supporter of submarine telegraphy; and when the history of submarine telegraphy is written, Lord Tweeddale's name will stand high on the register.

Mr. G. G. Nicol: I beg to second that.

The Chairman put the motion in the usual way, and it was carried unanimously.

The Marquis of Tweeddale: I beg to thank you, gentlemen.

Mr. Ford: The resolution which I have now to propose is not a formal one, for I recognise the efficient services which have been rendered to us by our auditors. I move:—

"*That Mr. Henry Dever and the firm of Messrs. Quilter, Welton and Company be and they are hereby elected auditors of the Company for the current year, with remuneration of £100 each.*"

Mr. Starnes: I have much pleasure in seconding that.

The resolution was put to the meeting and carried unanimously.

Mr. John Newton: In moving a vote of thanks to you I am not going to throw any apple of discord into the chorus of congratulations that this meeting has indulged in, but I do think that in proposing this vote to you I am giving expression to a thought that has passed through my mind—namely, that submarine telegraphy and your association with it have not yet received the acknowledgments which they should have received. It is a singular fact that the greatest civiliser that the world has ever known has not yet been recognised in the House of Lords. We have two or three noblemen on the boards of the various companies, but not one is in the House of Lords because of his connection with telegraphy. I think if you had been occupied in the career of arms, probably some of you would have been in the House of Lords; but you have been in a more peaceful field, and the consequences are that you are left outside the door of that great chamber. I think, notwithstanding the honour that you have had conferred upon you, it is not the honour that should have been done to those connected with submarine telegraphy during the last 30 years. Having said that, I will conclude by moving a vote of thanks to you and your colleagues for the work you have done in the past half year, and I trust that the indications that you have shown will result in a 6 per cent. dividend at the termination of the financial year. I think that a 6 per cent. dividend should not excite the cupidity of the Governments of the world, so that they would try and reduce it, because it is only 5 per cent. on the ordinary capital of those who invest in the Company. I think we should be entitled to look for a 6 per cent. dividend without any Government grudging such a return considering the splendid work that we have done.

The vote was seconded by a Shareholder, who at the same time referred to the latter part of Mr. Newton's speech about a 6 per cent. dividend. He thought an instalment of the bonus might have been paid with the present dividend, as promised, he believed, by their worthy chairman at the last meeting.

The Chairman: On the last occasion we gave a bonus for the half year because it terminated the financial year, but I said we had decided in the future to pay the bonus once a year; and I shall be very much mistaken if you do not get your bonus at the end of the coming half year. If you look at my speech as a whole you will see I dealt with the question of bonus as being a yearly, and not a half-yearly matter. We could have paid ½ per cent. to-day, but the principle of paying a bonus once a year is a sound one. If, however, the shareholder chooses to tell us it is an unsound one we will argue the question with him. We are not wedded to any point. I am quite sure that the principle is sound to pay once a year. Then you know what there is to carry forward and add to the reserve fund; and in an uncertain property like this I do not think it is right to keep our exchequer bare.

Mr. Newton: A vote of thanks is proposed and seconded. Those in favour of it will signify the same in the usual way. Carried.

The Chairman: On behalf of my colleagues and myself I thank you for this renewed expression of your confidence. I thank you more from the fact that Mr. Newton has proposed this vote. There is no one who has watched more closely or critically the working of this Company than Mr. Newton. He and I have had many spars across the table. I have listened always attentively to Mr. Newton's remarks, and we have adopted from time to time his suggestions. I am always pleased to hear Mr. Newton, because I know if there is a fault in our mail he is sure to find it out, and when a word of congratulation comes from Mr. Newton it comes with double force, and is doubly appreciated, and therefore when Mr. Newton does not find fault with the bonus being paid but once a year, I am quite sure that no other shareholder need complain. I thank you for your renewed confidence, and I am quite sure that if we differ on any small point the difference will be settled if you can convince us that you are right and we are wrong. We feel, however, that we know the "ropes," as Sir James Anderson would say, better than you, and we try and pull those ropes in such a way as will always secure stability and certainty in your dividends.

The proceedings then terminated.

The Direct United States Cable Company (Limited).

The twenty-first ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Friday, the 20th inst., under the presidency of Sir John Pender, K.C.M.G.

The Acting Secretary (Mr. T. Finnis) read the notice convening the meeting and the minutes of the last meeting, which were confirmed. The report of the Directors was taken as read.

The Chairman then said: I shall make my usual remarks on the report before asking you to adopt it. The revenue for the half year to 31st December, after deducting out payments, amounted to £23,003, and the working and other expenses, including income-tax, to £15,865, leaving a balance of £7,138. (I may mention, in passing, that that balance of £7,138 to-day at the 6d. rate, compares with £51,648 net profit at the 2s. rate.) The balance of £7,138 that is left is the net profit of the half year, making with £5,004 transferred from the reserve fund account (out of the interest received on the investments) a total of £12,142, which has been appropriated to the payment of the undermentioned dividends:—Final dividend of 2s. per share for quarter ended 30th June, 1887, £6,071; interim dividend of 2s. per share for quarter ended 30th September, 1837, £6,071—total, £12,142. A further interim dividend of 2s. per share for the quarter ended 31st December last has been declared, and is payable on Tuesday next, the 24th inst. The revenue at the sixpenny rate shows an increase of £3,399 as compared with the corresponding period of 1886, when the tariff was the same; but the progressive development in the traffic carried during the first half of last year, 1887, has not been maintained. The expenses in London show a saving in the items of salaries, office expenses, and repairs, with an increase in items of stationery and rent. The total exhibits a decrease of £458 for the half year. The expenses at stations show increases in the salary and stationery items, both caused by the large traffic at the cheap rate and the additional facilities given to the public. Reductions are shown in travelling ex-

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penses, repairs, and in freight. The total shows the slight increase of £130. The expenses on the whole show a reduction of £490 as compared with the corresponding period of 1886. It is very satisfactory to note that, notwithstanding the large traffic carried, and some additional outlay incurred through the action of the French Company, our total working and other expenses during the past half year were less than in any previous half year of the Company's existence. The item of cost of removing our cables and station to Halifax (which important work will be referred to presently) remains for the present in the balance-sheet. The Company's investments continue to be worth very much more than the amount of their cost to the Company. Gentlemen, I have given you some of the hard facts connected with the working of our system during the last six months. I shall now refer to matters which may interest you in our present state of low rates. Six months ago when I had the pleasure of addressing you I referred to the large development of traffic that had taken place under the sixpenny rate. I said I did not believe that rate would be a permanent one, but that while it lasted—while the development was going on—it would be a misfortune to make any change. We, however, have arrived at a position when the sixpenny rate seems to have ceased to bring about increased returns. Consequently the opinion that I expressed then as to the mode of dealing with the question I entirely endorse to-day. What I said more particularly at the last meeting was that the very large interests which the Western Union Company held in the land system in America, as also their interest in the cables, entitled them to take an active part in the settlement of this war of rates. They did take an active part in it, and they had settled the land rates in a way which I believe is now working satisfactorily, and you all know that the Western Union Company, while settling with the company which belongs to Mr. Mackay, have also secured the control of the Baltimore and Ohio telegraph system, giving them a largely increased power in working the land system of telegraphs in America. There were some negotiations in America between Mr. Gould and Mr. Mackay. They were referred to this side, but the proposals were such that they could not be entertained. The consequence was that there was no result, and we are now in the position of having been rather blamed for not agreeing at once to the proposals then made. If, however, we had accepted these proposals, we should have been positively guaranteeing a very high rate of interest to the Commercial Company; in short, it would have been giving them a very high premium for laying cables in the Atlantic when there was no real necessity whatever for them. On this point I have frequently spoken. We are in this position to-day, that we have worked for nearly two years at the sixpenny rate. We have got pretty much all the good out of it for the moment that we are likely to get, and, speaking for myself and, I believe I may say, with the full concurrence of my Board, I should be very pleased to see a conference of the different companies held to consider the question of a fair rate for the shareholders, and an equally fair and just rate for those who use the telegraphs. Some one must lead in it, and we occupy a position respecting which we may say that the Western Union not having brought about any arrangement, something should be done on this side. I speak on behalf of my Board, and also, I believe, on the part of the shareholders I am now addressing, because, I believe, every one of them would like to see better rates and dividends than we are able to pay them under the present tariff. You are aware that the other day the suit which was brought against the French Company for seceding from the "pool" terminated, at least the decision for the time was, in favour of the Anglo-American Company. That decision meant that damages to a very considerable extent were to be paid by the French Company. I never expected any other decision from a commercial jury, because it is simply common sense that men who enter into an obligation are bound to carry that obligation out. They chose to break it, and the result is that they pay the penalty. Whether the judgment will be legally sustained on appeal, I am not a lawyer and cannot give you an opinion; but I would say, and I say it to the French Board with all courtesy and respect, that I believe instead of appealing to the courts to have this decision put aside, it would be very much better, and very much more satisfactory to them in the long run, as they have already incurred very heavy responsibilities which they must pay, if they were to appeal to us to meet together to endeavour to bring about a rate that would recoup them for the work and large expense they had been at from time to time. I think that would be very much more satisfactory, and I think it is the step that the Directors would be wise, in the interests of the shareholders, and in the interests of telegraphy generally, to take. I should be very pleased to receive a communication from them to try and meet them as far as we could to bring about a satisfactory solution. I think I have now pretty well given you the position we occupy at the present time. Some one may ask me about what rate I would suggest. I am not prepared here definitely to say what the rate would be; but I think if we could maintain the traffic which we have developed at 6d. upon a 1s. tariff it would not be a burden to the telegraphing public, and it would be very much more advantageous to us. If at the end of 12 months we did not find the one shilling tariff give us proper returns, we could reconsider the question, as I think the shareholders are fully entitled to be considered in regard to all this question with a view to giving a fair dividend on the capital they have invested. A one shilling tariff, as you know, has been very often talked about. I may mention that while we were, in the late negotiations that were going on, prepared to deal with the shilling tariff, those connected with the other companies—the Commercial and French Companies—were looking to a return to the old rate of 1s. 8d. I think that for a time we may consider that that is not likely to take place, and that the lower rate is more likely to be agreed upon. I have told you something of the present position of our negotiations, and of the position we occupy in the "war" of rates. I will now refer to the alterations we have made during the last six months in our cables. We have sustained very heavy loss from our cable lying on Brown's Bank; the interruptions there have been very frequent. Out of the total breaks in the short section of cable about 75 per cent. have occurred on that Bank, and some £68,000 have been expended in repairs to this one section since it was laid down. We have now removed that portion of short cable away from Brown's Bank, and have taken it into deeper water, and consequently we may now, I believe, hope to be free from the large expenditure which we have had from year to year to undertake. Our cable being in Halifax, if the Government desire to have a cable carried to Bermuda we are quite prepared to meet their requirements. With these remarks I shall be pleased to answer any questions, and I will now propose the resolution:—"That the report of the Directors, dated the 6th January, 1888, together with the statement of accounts to the 31st December, 1887, annexed thereto, be and the same are hereby received and adopted."

Mr. Wm. Ford seconded the motion.

A Shareholder inquired if the vacant seat at the Board was to be filled up.

Mr. Griffiths congratulated the shareholders on the well earned honours which the Chairman had had conferred upon him by Her Majesty. He saw in the report that £5,000 had been paid to the Anglo-American Company under the agreement. He desired to know what the terms of the agreement were, and how long it would last. He supposed when it terminated they would have the power of renewing it. With regard to the lawsuit in France, he was glad to see that already they had a prospect of obtaining £30,000 in connection with it. He desired to know what portion of that would come to the Company under the agreement, and what portion would go to the Anglo-American Company. They might hope there were good grounds for believing that they would sustain the verdict which the jury had given.

The Chairman, in reply, said that the payment of £10,000 a year to the Anglo-American Company was a very old story. It was contracted in the early days of the Company with a view to the joint-purse agreement. When they made the agreement with the Anglo-American Company they got a very much larger percentage of the purse than was supposed by many that they were entitled to. They therefore compromised the matter, to some extent, by paying the Anglo Company £10,000 a year, the company maintaining their full 25 per cent. The £10,000 was paid in a great measure, —the Direct being a single cable company—for guaranteeing the maintenance of their revenue in the event of any interruption. That entitled them to receive for twelvemonths their full share of the "pool," and he thought up to two years a very considerable portion of it. It was paying for a guarantee rather than going to the expense of laying a second cable. With respect to the suit with the French Company, Mr. Griffiths was a good lawyer, and if he looked into the thing he would find that it was the Anglo-American Company who had raised the suit. They had got the decision, and it remained for the Direct Company to raise another suit to obtain damages if that proceeding should be considered advisable. Meantime he thought the less they said about the question the better till the money was in their hands to be divided.

Mr. Guesdon said he had not had time to go to the office to read the contract between the Company and the Anglo-American Company; but he looked on it as a most valuable arrangement for the Company, and the payment mentioned of £10,000 a-year was one that the shareholders might make with great satisfaction. If the shareholders wished to know anything about the value of such an arrangement they had better compare the price of the Direct Company's £20 shares with those of the French Company, which he believed were a mere fraction. He saw that there was a reduction of the reserve fund between 1883 and 1887. If they took that into consideration, as well as the wear and tear and depreciation of the cable during the same period of four years, it would, he feared, be found that they were sinking their capital very fast. As far as the contest with the American Cable Company was concerned he was not in a position to offer any opinion, but he did not feel sanguine upon the subject, because whatever might be the merits of the case, the sympathies of the Americans would be in favour of their own company. Reference had been made to the progress anticipated from the reduction of the tariff not being maintained, but the question was to see how far that condition of things applied to other companies, and if the contraction only applied to the Direct and Anglo-American Companies it would seem as if the American Company was gaining ground. He believed their agreement with the Anglo-American Company was for ten years.

The Chairman: I believe it is far nearer thirty years.

Mr. Guesdon said he thought they had secured a very valuable protection. It was stated that the number of Directors had been reduced. He wished to know whether it was intended to fill up the vacancy. He regarded the Directors as partners and as trustees also. He maintained that the shareholders were getting their dividends not out of profits but out of their capital, and that the Directors from the same source were receiving their fees, and if he were in order he would move a resolution on the subject.

The Chairman said that Mr. Guesdon would not be in order in doing so.

Mr. Guesdon thought that the Directors ought to sympathise with the shareholders in the present circumstances.

Mr. John Newton said he could not agree with some of the remarks which had fallen from Mr. Guesdon. He contended that the Directors were distributing to the shareholders on the present occasion nothing but their income, for the reserve fund had been accumulated in past years out of income. The money was their capital in one sense, but the income derived from it must be their revenue; and if the income they earned was not sufficient to provide for that bread and butter, he held that the bounden duty of the Directors was to distribute the reserves of previous revenues which they held. They might have paid the shareholders justly and fairly 3 per cent. instead of a paltry 2 per cent.

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Mr. E. M. UNDERDOWN, Q.C.: We could do that if it were thought wise.

Mr. NEWTON knew that that was so, and the Directors, he considered, were to be blamed for not doing so. There was an enormous accumulation of reserve—nearly 27 per cent. of their capital—which had been taken from their revenue in prosperous years. If the fight had to be continued for the next two or three years no harm, he felt sure, would result in distributing £12,000 a year among the shareholders. He expressed great satisfaction at the honour which had been conferred upon the Chairman, but he maintained, as he had at another meeting, that it was not the honour which the Chairman and others connected with the cable enterprise had well deserved from statesmen and governors of this country, having regard to the marvellous benefits which telegraphy had conferred upon the world.

Mr. WEATHERLEY agreed with Mr. Guesdon's remarks concerning the Directors' fees. In view of the dividend that was being paid to the shareholders, he thought that they ought to receive some concession from the Directors. He understood that it was not the intention of the Directors to fill the vacant seat at the Board, and he presumed that if another Director were not appointed the amount of the fees would be reduced.

The CHAIRMAN, in reply, said that the reserve fund was meant especially for repairing cables, and also, if necessary, for laying a new cable. If they were at such a time as the present to trench upon the reserve fund proper to supplement their dividend, they might find if the "war" were to continue for a certain time that all their reserve fund might disappear, and their cable would be so much older, while their credit would be of a very unsatisfactory kind, and their shares would stand in the market very much as the French Company's shares now stood. He felt sure that Mr. Newton would understand that it would never do for a company like theirs, having such a property, to be without a reserve fund. He agreed with Mr. Newton that in a time like the present, when they were fighting to maintain rates and dividends, they ought to go as far as they possibly could in supplementing the dividend from the reserve fund. Therefore they took every shilling of interest that the reserve fund earned for them and applied it to supplement the shareholders' dividend. He thought that in that way they met Mr. Guesdon's views, and he believed that when Mr. Newton thought it out seriously he would admit that it met his policy as well. In Mr. Guesdon's remarks about the reserve fund he had evidently overlooked the fact that in 1884 £100,000 of debentures had been paid off. With regard to the remarks which had been made about the Directors' fees, he thought that the Directors were entitled to ask the shareholders for their sympathy. Since they took office they had built up a large reserve fund and gone on for a long time paying 5 per cent. dividends, and under the Articles of Association they could have drawn very much more than they had for their fees. They should also remember that when things were working smoothly, there was not much difficulty, but at a time like the present the Directors had to watch every turn, and they did everything they could to promote the shareholders' interests. They could have taken under the Articles of Association 33 per cent. more than they had taken for their fees, and then they would only have taken what the Directors of the old company took before the present Board assumed office. The Directors paid for the proxies which had been issued. There were 50 or 60 shareholders present, whereas there were nearly 1,500 shareholders in the Company, and he maintained that it would not be right or just that absent shareholders should have no opportunity of expressing their views. With regard to the vacant seat at the Board, that had been caused by the death of Lord Hawke, a gentleman who had been associated with them from the beginning, who was a regular attendant and a man of good judgment. When he died they thought it would not be wise to fill up his place, and the fees which he received did not go into the pockets of the other Directors, but into the exchequer of the Company. He did not say that they would not fill up the vacant seat, as it might be desirable to do so with a view to protecting the interests of the Company. In the meantime, however, they had decided not to fill up the vacant seat.

A SHAREHOLDER asked if it would be possible to take a vote on the question as to whether the vacant seat should be filled up.

The CHAIRMAN said that such a question could not be put, as it would be out of place that day.

Mr. UNDERDOWN observed that the Directors had a right to fill up casual vacancies at the Board.

Mr. NEWTON maintained that a recommendation could be proposed to the effect that the vacant seat at the Board should not be filled up. For his own part he would not support such a resolution. At the same time he thought that the Directors ought to be inclined to listen to suggestions on the matter. If the vacancy was filled up he thought it would be politic to appoint a younger man, so that there might be continuity on the Board.

The CHAIRMAN, in reply, said that Mr. Newton had been a regular attendant at their meetings, and his suggestions had been adopted from time to time, and when any shareholder made a suggestion in a proper way, he and his colleagues gave them full consideration. They had said that they were not going to fill up the vacancy just now. With regard to the wise observation of Mr. Newton, if it was filled up it would be filled up by a younger man probably than any present member of the Board.

Mr. GUESDON said that if five men could not manage the Company fifty could not.

The CHAIRMAN admitted that two or three men might just as well manage as a dozen, but that was not the view that was entertained in the present day. What was wanted now was representation, and the Board of the Company was very representative.

He then put the motion, and declared it carried, afterwards thanking Mr. Griffiths and Mr. Newton for their kind observations respecting the honours which had been conferred upon him.

On the motion of Mr. GRIFFITHS, seconded by Mr. WEATHERLEY, a hearty vote of thanks was passed to the Chairman and Directors for their management of the Company's affairs for the past half year.

The CHAIRMAN, in acknowledging the vote, said the shareholders might rest assured that while they had the conduct of the affairs of the Company they would act in such a way as to secure the confidence and support of the shareholders.

The proceedings then terminated.

CITY NOTES, &c.

THE ANGLO-AMERICAN TELEGRAPH COMPANY.—At a meeting of the Board of Directors of the Anglo-American Telegraph Company, held 20th January, it was resolved to recommend to the proprietors at the next half-yearly general meeting of the company, to be held on the 3rd February next, the declaration of the following dividends:—1. A balance dividend of 10s per cent. upon the ordinary consolidated stock for the year ended 31st December, 1887. 2. A balance dividend of 20s. per cent. upon the preferred stock for the year ended 31st December, 1887. Both payable on the 4th February next, less income-tax, to the stockholders registered on the books of the company on the 16th inst. After paying the foregoing dividends, there will be an estimated balance of £2,300 to be carried forward to the next account. The above dividends, together with those already paid, will amount to £1. 7s. 6d. per cent. on the ordinary consolidated stock, and £2. 15s. per cent. on the preferred stock for the year 1887. The register of transfers will be closed from 20th January to the 3rd February, both days inclusive.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—Mr. W. J. Andrews has been elected chairman of this company, in place of Sir Henry Drummond Wolff, who has resigned his seat at the Board. The directors have elected Lord Richard Howe Browne to fill the vacant seat at the Board.

ALTERATION OF TELEGRAPH TARIFF TO TURKEY.—The Eastern Telegraph Company notifies that on and after 1st February the rates for telegrams to Turkey, *viâ* Gibraltar, Malta and Zante, will be reduced from 10d. to 7d. per word, being the same charge as by the Government land lines. The company suggests that telegrams for Turkey should be handed in at its own stations, 11, Old Broad-street; 41, Parliament-street; or 37, Holborn Viaduct. When sent from postal offices they should be marked "*Viâ* Eastern."

AWARDS.—Messrs. Woodhouse and Rawson have been awarded a gold medal at the Saltaire, and a bronze medal at the Newcastle Exhibitions.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Jan. 25.	Business Done Week Ending Jan. 25. Highest.	Lowest.
Anglo-American	40¼, 41¼	40	38¾
Do. Preferred	67, 68	65⅞	62
Do. Deferred	14½, 15½	15 1-16	13½
Brazilian Submarine	12, 12½	12 3-16	12
Cuba	12½, 13	—	—
Do. Preference	18, 19	18¾	18½
Direct Spanish	3¾, 4¼	3¾	—
Do. Preference	8½, 9½	—	—
Direct United States Cable	8¾, 9¼	9	—
Eastern Telegraph	11¼, 11½	11¼	11¼
Do. 6 per Cent. Preference	14¼, 14¾	14¼	14¼
Do. 5 per Cent. Debentures, 1899	108, 111	110	108¾
Eastern Extension	12 7-16, 12⅝	12½	12
German Union	9, 9½	—	—
Globe Telegraph and Trust	5¾, 5⅞	5¾	5⅝
Do. Preference	13¾, 13⅞	13¾	13⅝
Great Northern	13⅝, 14	13⅝	—
Indo-European	38, 40	39	—
London Platino Brazilian	4¾, 5¼	4 15-16	—
Reuter's	7¾, 8¼	—	—
Submarine	140, 150	—	—
West Coast of America	5 5½	5 1-16	—
Do. Debentures	110 115	—	—
West India and Panama	¾, 1	—	—
Do. 1st Preference	9½, 10	—	—
Western Brazilian	8⅞, 9⅜	9¼	9
Western Union 7 per Cent. 1st Mortgage	120, 125	—	—
Do. 6 per Cent. Sterling Bonds	101, 104	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	9-16, 11 16	—	—
Oriental	¼, ¾	—	—
United Telephone	11¾, 12¼	12 1-16	11⅞
United River Plate Telephone	4½, 5	—	—

ELECTRIC LIGHT.

Anglo-American Brush Light (£3 paid)	3, 3¼	3 3-16	3
Do. (fully paid)	4, 4½	4¾	3⅞
Swan	1⅜, 1⅝	1½	—
Maxim Weston	3-16, 5-16	3-16	—

MISCELLANEOUS.

Telegraph Construction	38, 39	39	—
India Rubber, Gutta Percha and Telegraph Works	20½, 21½	23	21¾

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

The sudden rise in the price of telephone shares since Mr. Raikes' speech of last Friday, is, perhaps, not wholly to be regretted, if it convince the Postmaster-General of the public belief and desire that the telephone shall be put on the same footing as the telegraph. We have commented on this subject at length in our leading columns; and we have only to reiterate here that, as an expression of opinion, the Postmaster-General's words were worth noticing; but they afford not the least justification for assuming that the Post Office is going to take over the telephones as it did the telegraphs. The contradiction which appeared in the *Daily News* on Tuesday, although made probably without authority, was substantially correct.

We learn that it is proposed to have a conference at which all the Atlantic Telegraph Companies will be represented, with the view to the adoption of a uniform tariff. A shilling rate seems to be the most generally approved; but so far the matter has not been discussed.

In our leading article we have referred to the probable necessity for expending considerable sums on the reorganisation of the telephone system of wires in our large towns, notably in the metropolis. To what extent this may be thought desirable will be gathered from an article on the subject by Mr. Walker Moseley, the first portion of which we print in another column. Without binding ourselves to Mr. Moseley's plan, still less to the arguments by which he endeavours to show the necessity for its adoption as an independent system, we think it sufficiently evident that to meet the future needs of the telephone service some systematic method for extending operations will have to be devised, either entirely new or connected with the existing system.

Our New York correspondent's letter this week indicates that the infliction of capital punishment by electricity has been taken up in the States with greater seriousness than we had imagined, and in quarters where we should have expected a keener sense of the fitness of things. One of the Reports declares that "electricity is the most potent engine of death at present known." A more infelicitous description with which to label electricity at the present moment could hardly have been chosen. Without wishing them any harm, we venture to hope that the next man or woman any of the framers of this Report may have the misfortune to kill in the course of their legitimate business will be described as having been "executed" by Messrs. So-and-so, the eminent firm of Electrical Engineers. This might have the effect of bringing them to their senses.

Some interesting figures relating to the destruction of theatres by fire were given by Mr. W. Emden at the Society of Arts last Friday. The list is a very heavy and alarming one. It is satisfactory to notice that only two lives have been lost in fires caused by the electric light, and that only on this occasion was the theatre destroyed. In the other cases the fire was observed and extinguished. One, at least, of the instances cited was due to an accident with the arc lights during the building of the theatre, when no extra precautions had been taken.

The discussion on Mr. Cockburn's paper on safety fuses at the meeting of the Society of Telegraph-Engineers on Thursday last was of a thoroughly practical character, and it is a matter for congratulation that the subject should have been so well thrashed out. At the same time we fully endorse the remark of Mr. Crompton—which was also backed up by Messrs. Mordey and Esson—that a vast amount of nonsense has been talked (elsewhere) about the precautions against danger of fire from electric lighting. We would not say a word to discourage the adoption of all reasonable precautions in every installation; but, as we have already had occasion to assert, the continual and unnecessary discussion of these questions has had the effect in some quarters of shaking public confidence in electric light. It is for this reason that we have always deprecated the want of harmony which exists between the Committee of the Society and certain of the Fire Insurance Offices. As a natural consequence we have just learnt that one of the Insurance Companies is preparing an independent set of rules on its own account. We shall therefore shortly have three separate sets of regulations in the field.

Prof. Silvanus P. Thompson is of opinion that an important consideration affecting the choice of metal for use in lightning conductors has hitherto been overlooked. In a paper read before the Physical Society on Saturday last he set forth the view that the temperature of fusion should be taken as a factor in estimating the efficiency of a conductor. It is, at least, undeniable that if there existed two metals alike in all other respects, that metal which had the highest melting

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point would be most suitable for the purpose. The question then arises whether any cases have been recorded in which a lightning rod properly constructed has been fused. If so, it would become necessary to consider whether it were more economical to increase the sectional area of the conductor or to employ some other less fusible metal. It is from this point of view that Prof. THOMPSON speaks of "the price of the factor of safety in lightning conductors."

IN the discussion which followed the reading of the paper some doubt was expressed as to whether a case of fusion has ever been known to occur with a conductor properly connected to earth. But be this as it may we think it will be admitted that the question raised by Prof. THOMPSON is one which should now receive the fullest consideration. Unfortunately the calculations presented with the paper were to some extent vitiated, at least in the case of iron, by the neglect of so important a factor as the coefficient of self-induction. In taking this course the author probably contemplated the use of iron only in the form of stranded wire; but, even so, it appears by no means certain that the self-induction coefficient is negligible in comparing iron with copper. On the other hand, it would certainly be very difficult, if not impossible, to embody the influence of self-induction in a general formula for the heating effect.

THIS point is all the more important because, taking Prof. THOMPSON'S interesting table as it stands and neglecting self-induction, we find that if a copper conductor with a given factor of safety costs £100, we may obtain the same degree of safety with an iron conductor costing only £21. 9s., so that the argument in favour of iron is a very practical one. A conductor of lead or tin would prove an expensive luxury, costing more than six times as much as copper, while if any one happens to have a whim for using platinum he will be interested to learn that the relative cost would amount, at the present market value of that metal, to over £1,620,000—a figure which may perhaps be considered prohibitive.

PROF. S. P. THOMPSON is not the only authority who is inclined to advocate a return to the use of iron for lightning rods. Dr. L. WEBER, in a work recently published in Germany, under the title of "Information and Advice relating to the erection of Lightning-Conductors," not only recommends the use of iron in preference to copper, but actually goes so far as to state explicitly that a solid rod is better than a stranded wire cable of equal cross section. We feel sure that Prof. THOMPSON would not countenance this advice, and it seems strange that in a country like Germany, where lightning is much more destructive than with us, it should have been allowed to pass—so far as we know—without further protest.

IT is a curious fact that the generally received opinion as to the area of the zone over which a given conductor is capable of affording protection has undergone a continuous diminution from the time of GAY-LUSSAC downwards. In a famous report drawn up by GAY-LUSSAC for the French Academy, in 1823, it was held that a conductor 100 metres in height would afford protection over a *cylindrical* space having a radius of 200 metres. Later opinions as to the figure of the protected space have oscillated between the cylindrical and the conical form; but theoretically there can, we think, be little doubt that the true figure is conical. The following table gives some of the views held by the leading authorities on this subject, the height of the rod being taken as unity in each case :—

Name.	Figure.	Radius of Protected Area at Ground Level. Height of Rod = 1.	Date.
Gay-Lussac	Cylinder	2·00	1823
De Fonvielle	Cone	2·00	1874
Paris Commission	Cone	1·75	1875
Chapman	Cylinder	1·00	1875
Adams	Cone	1·00	1881
Preece	Special Cone	1·00	1881
Melsens	Cone	0·50	1884

Mr. PREECE'S protected zone is described by a cone the sides of which are concave, and are marked out in section by an arc of 90° described from a point on either side at the level of the top of the rod, and distant from it by its own length. It must, however, be admitted that, whatever may be the true theory, such calculations as these have only a slender value in practical application. The actual extent of the protected zone must largely depend on the size, shape and structure of surrounding buildings. That the smaller values are more likely to be generally true than the larger is proved by more than one recorded instance, in which lightning has struck the deck of a ship when the conductor on the mast-head has been in perfectly good condition.

WE commend Mr. FLOOD PAGE'S letter in *The Times* of Tuesday not only to Members of Parliament, but to members of the electric lighting profession generally. It is remarkable that an appeal to the leading newspaper against the legal disabilities imposed by the Act of 1882 should come from the secretary of a single electric lighting company. This is the time for united action; and if electrical engineers have not yet made up their minds to formally associate under one title, they at least ought to combine in action for an object common to them all.

AN interesting experiment in long-distance telephony has just been carried out in France. It was some time ago decided to connect Paris with Marseilles by telephone, the distance being over 500 miles. Seeing that no telephone line of this length as yet exists in Europe, the authorities were anxious to make some practical experiments upon as large a scale as possible before undertaking the work. For this purpose, with the co-operation of the Belgians, a special circuit was made up of existing bronze wires, as follows :—Antwerp to Brussels, Brussels to Paris, Paris back to Brussels by the second line, *viâ* Momignies, Brussels to Verviers, the total length between the terminal stations by this route being about 620 miles. The results are said to have been of a highly satisfactory character,

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the articulation being as clear and distinct as that between Brussels and Paris.

SPEAKING of long-distance telephony, there is a paper in the *Philosophical Magazine* this month which no one interested in this subject should omit to read. It is unhappily true that there are very few men engaged in practical work who will be able to follow Mr. OLIVER HEAVISIDE'S abstruse exposition of the principles of electro-magnetic induction; but every one can recognise the importance of a statement like the following, coming as it does from one of the first living authorities in the mathematical theory of electricity. On page 137, Mr. HEAVISIDE says, "It seems to be imagined that self-induction is harmful to long-distance telephony. The precise contrary is the case. It is the very life and soul of it. . . . I have proved this in considerable detail; but they will not believe it." The proof referred to may be studied in detail in *The Electrician*, Vols. XVIII. and XIX.; but, unfortunately, it is not in such a form that he who runs may read. It would, perhaps, be a good thing, if we were some day to publish a gloss upon these papers adapted to the understanding of the ordinary electrical engineer. This is not, however, the only passage of general interest in Mr. HEAVISIDE'S paper; many of our readers will be surprised to learn (the remark is quoted from MAXWELL), that "for anything we know to the contrary, the velocity of electricity *in a wire conveying a current* may be only one inch or so in an hour." Later on we are introduced to a conductor "having a time constant of one fortnight." These little pleasantries are continuously cropping up in the most unexpected places in the writings of this learned author, and it seems a pity that they should be lost in a wilderness of quaternions.

ANXIETY about sea-coast defences is not confined to this country. An American scientific contemporary, commenting on the undefended condition of New York, makes the following characteristic onslaught on a recent experiment conducted by Major KING, which we described at the time:—"Is it not a scathing comment upon this scandalous condition of affairs that the commandant of our principal torpedo station at one of the principal forts supposed to defend New York can find no better use for the war material in his charge than to wind his worthless old cannons with worthless old torpedo cable, and try experiments in electro-magnetism?" Really our American brethren might take consolation from ourselves. Worthless stores may be put to far worse purposes than experiments in electro-magnetism; and with us they are apt to lie completely idle till the serious experiment of warfare has demonstrated their worthlessness for any purposes whatsoever.

THE "proverbial uncertainty of the electric light"—as the gas journals say—is aptly illustrated by the following little incident, which is, we believe, authentic. A lamp had been hung from the kitchen ceiling by flexible leads; so when the housemaid wanted a light in the cellar she did not hesitate to cut off the lamp and hang it from the bell-wire. Then she said she "didn't never believe in these here new-fangled notions."

Club Lighting.—Specifications have been issued for the electric lighting of St. Stephen's Club.

Copper.—The price of copper has slightly risen during the week, Chili bars being quoted yesterday at £75. 5s. to £75. 15s.

Syra.—According to a French Consular Report, it is intended to provide an installation of electric light for the harbour of Syra.

"L'Electrotherapie."—A new monthly journal devoted to medical electricity is about to appear in Paris, under the title of *L'Electrothérapie*. It is to be edited by Dr. Danior.

The Electric Light and the Theatres of Madrid.—The *Dia* states that the contract has been signed by the firm of Bloss of Madrid for the immediate lighting by electricity of the Principe Alfonso Theatre.

The Treatment of Sewage by Electricity.—The Metropolitan Board of Works, at their meeting last Friday, resolved to permit Mr. W. Webster, jun., to carry out an experiment on the sewage of Crossness, with his system of electrical purification. For this purpose he is to have the use of one of the tanks; the trials to be made at Mr. Webster's own expense, and under the supervision of the officers of the Board.

Incandescent Lamps.—M. Hees has carried out some experiments in order to determine the effect of variation in the degree of the vacuum in an incandescent lamp upon its photometric power. On gradually increasing the pressure no effect was perceptible up to a vacuum corresponding to 2 mm. of mercury, but from this point the light rapidly fell off, and at 6 mm. of mercury it had fallen to only one-third of its original value.

Trade Catalogue.—The United Electrical Engineering Company, of 36, Albert Embankment, send us a copy of their newly-issued catalogue of electrical supplies. This is one of the most complete lists of electrical requirements which we have come across. Considerable care has evidently been devoted to the book, and the tabulated information concerning dynamos, accumulators, &c., will be found very useful to intending buyers.

"Fifty Years' Progress in Telegraphy."—Under the auspices of the Sunday Lecture Society, Mr. William Lant Carpenter, B.A., B.Sc., delivered a lecture on Sunday afternoon last, at St. George's Hall, Langham-place, on "The Electric Telegraph; its Past Half Century, and its Recent Progress." There was a numerous attendance, and the lecture, which was illustrated with experiments and diagrams shown by means of the oxy-hydrogen lantern, was listened to with great interest.

The Deposition of Aluminium.—Aluminium is one of the most difficult and uncertain of metals to deposit electrolytically. The following recipe is given by M. Herman Reinbold, who states that it furnishes excellent results:—50 parts by weight of alum are dissolved in 300 of water, and to this is added 10 parts of aluminium chloride. The solution is heated to 200°F., and when cold 39 parts of cyanide of potassium are added. A feeble current should be used.

The North Metropolitan Tramways.—At the general meeting of the shareholders of the North Metropolitan Tramways Company on Wednesday, the chairman (Mr. George Richardson) stated that extensive experiments were being made in connection with the use of electricity on their system. He could not say whether the experiments would prove successful or not, but the company incurred no risk in connection with them; and if it could be shown in due course that electricity could be profitably used on their lines, they would derive the advantage of it.

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The Lighting of the Cardiff Docks.—The arrangements for lighting these docks by electricity are nearly completed. A powerful Brush dynamo machine has been placed near the Bute Graving Dock, and this will supply current for a number of Brush lamps placed at the entrances and round the basins of each dock. The entire Roath Basin will be lighted by electricity. The upper portion of the docks will still be lighted by gas from the Bute Gasworks, but this system will be abandoned after a time, and another dynamo machine placed at the upper end of the dock. For the lighting of the entrances, basins and part of the new docks nearly 100 large lamps will be used.

Spanish Tender for Electric Light.—The directors of the Madrid Mercantile Club (Circulo de la Union Mercantil) invite proposals for lighting the club by electricity. The conditions, which are published in the *Comercio Espanol*, of Saturday last, provide for the installation of three arc lights, and 160 to 200 lamps of 16 candles. As the club premises have not a convenient place for installation, the machinery and apparatus will have to be located in a separate building. Proposals drawn up in accordance with the detailed requirements published in the Madrid paper must be sent to the president of the club before the 1st of March next. The duration of the contract, the daily supply of light, and the amount of guarantee to be deposited by the contractor are all subject to arrangement.

The Post Office and the Telephone Companies.—On Friday last the Postmaster-General, in the course of a reply to the Wolverhampton Chamber of Commerce on the subject of postal and telephone charges, remarked that—

"Respecting telephones, it was unsatisfactory that the Government had to compete with private firms, and before long the system must be taken up by the Government, and telephones placed on the same footing as telegraphs, and be controlled altogether by the Government."

On Tuesday the following paragraph appeared in the *Daily News*, but we believe in no other paper:—

"We are officially informed by the Postmaster-General that the statement that he had announced the intention of the Government to acquire the telephones is erroneous. Mr. Raikes has announced no such intention."

Our own views on this subject are fully stated in other columns of the present issue.

Dynamicables and Electro-Harmonics.—The dinner of the Dynamicables, which was held at St. James's Hall on Friday last, was largely attended, and proved to be a very enjoyable gathering. The post-prandial proceedings were cut shorter than usual by the announcement of an invitation from the Electro-Harmonic Society. The Dynamicables were invited to attend the Society's Smoking Concert, which was held the same evening in the same building. The concert proved to be one of the most successful which the society has ever given, and the attendance was both large and enthusiastic. The programme consisted chiefly of old English songs, together with a judicious selection of modern ballads of a comic cast. We heartily congratulate the committees of each of the clubs concerned on the success of Friday night's proceedings.

Electrical Method of Rendering Visible the Form of Vibrating Strings.—Herr J. Puling, of Vienna, has devised an extremely ingenious method of rendering visible the form of a stretched string set in vibration. One of its extremities is attached to the prong of a tuning-fork, which is kept in motion by an electro-magnet contact breaker, and which gives a definite note, the pitch of which is carefully determined. The vibrating string is lighted up by a vacuum tube connected with a Ruhmkorff coil, the rate of discharge through the tube being alterable at will, and when this is made equal to or some aliquot multiple of the number of vibrations made by the string, the latter is only illumined when occupying some one definite position, and, owing to the persistence of its image on the retina, it appears as if at rest. In this way the form assumed by the string and the positions of the modes and ventrical segments are rendered clearly visible.

Electric Traction on the Metropolitan Railway.—As already announced, in the report of the directors of the Metropolitan Railway Company submitted at the shareholders' meeting last Friday they stated that negotiations with the Electric Traction Company had enabled them to conclude an arrangement whereby that company had undertaken to construct, at their own expense, for experimental running upon a section of the railway outside the circle, a locomotive of the same power as the company's present steam locomotives, the directors giving them the necessary facilities for such experimental working. In reply to a question on the subject, the chairman (Sir E. W. Watkin, Bart., M.P.) stated that they were doing all they could to assist in making practical experiments with regard to electric locomotives. He could not say whether the matter would succeed or not; but the directors thought that if their railway could be worked without the emission of smoke and steam—that was to say, if their tunnels could be made as pure as the air in the street above them—it would be a very great advantage.

The Electric Light at Exeter.—The *Western Morning News* says that "the public at Exeter have been trifled with over the electric light. Private speculators came to the city some weeks ago, and obtained the sanction of the council to erect poles in the city. It was announced, on the authority of the local agent, that the streets were to be lit by electricity for a month. But instead of that, a number of tradesmen were got to subscribe for lamps in connection with their establishments, and the poles were used to convey the current for that purpose, whilst the public, in whose behalf the poles were presumably erected, were neglected. At last, however, it seems that the streets are no longer to be disfigured and the kerbing broken up through the erection of these poles to no purpose, for several arc lamps were hung yesterday with a view to lighting the streets. This may be some compensation for the delay, disappointment, and inconvenience which have been caused. To the electric light, as exhibited since Christmas, citizens of Exeter do not, however, as a whole take kindly, the principal objection being that the light is too glaring for the eyes. This is possibly the fault of the globes."

The Commissioners of Sewers of the City of London and Electric Lighting.—At a recent meeting of the Commissioners of Sewers of the City of London, the Remembrancer (Mr. Goldney) made a statement respecting an application of the South Metropolitan Electric Supply Company for a Provisional Order to light a large part of the eastern and western ends of the City. He said that a part of the area would comprise a portion of the district which he understood the Commissioners had before them with reference to the Brush Company. The Provisional Order, if obtained, would give the supplying company a monopoly of the ground specified; and if the Commissioners determined to give the lighting to the Brush Company, they must oppose it. It would be hardly possible for the two companies to occupy the same area.—Mr. Ashby thought they ought to let the companies do as they pleased.—Mr. Bell expressed surprise that the last speaker should object to the Commissioners giving themselves *locus standi.* While they were

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on the point of coming to a conclusion, another company was seeking to obtain a monopoly and shut them out. The company referred to wanted to put inumerable wires overhead. He moved that instructions be given to oppose the Bill, and this was agreed to.

An Enticing Offer.—Mr. F. H. Bowman has written to the *Bradford Observer* as follows:—"I see that a consultation between the Corporation and their electrical engineer, along with Dr. Hopkinson, F.R.S., is being held to-day to fix on the general scheme for the lighting of the town, and I trust, therefore, that before long something will be done. Since I last wrote to you, in consultation with our engineer, I have formulated a plan by means of which Bradford can be supplied with electricity without any cost for the current itself—a plan which I am perfectly certain will work, and which will secure all the special points which Mr. Priestman wishes to obtain, viz., that the current will be available at any time, night or day, and can be supplied to the customers either at a high or low pressure (in tension or quantity). This system, if applied, will enable each customer to select how he will receive his current, depending on the work which he requires from it, and it can be supplied either by measure or time. If this scheme is adopted, the fact that the current will cost nothing to generate it, and the first cost of the plant being reduced to the minimum, will render it possible to supply Bradford with a large quantity of electricity for all purposes at as little cost as if there was a large waterfall available in the neighbourhood."

Telephonic Concert at Stafford.—On Tuesday evening last, the National Telephone Company (Limited) gave an interesting telephonic concert at the residence of Mr. W. O. Rooper, at Stafford, at which over sixty of the leading residents of the district were present. The music, both vocal and instrumental, was provided by Dr. E. W. Taylor, at his residence, Wolverhampton-road. At Mr. Rooper's residence a large room had been fitted up with a number of "receivers" attached to the tables at which the company sat. Before commencing, Mr. Alfred L. E. Drummond, the local manager of the Telephone Company, in the course of a short speech, explained that what he wished to demonstrate that evening was that the telephone, in addition to being useful for ordinary conversations, was quite capable of being used for the transmission of music, and in fact for any variety of sounds. He also explained that the entire music was transmitted over only one line of wires, and was distributed through over thirty receivers in the concert room, this being a very severe test. The audience were quite enthusiastic at the conclusion of the concert, when "God save the Queen" was sung. The musical performers and the National Telephone Company, through Mr. Drummond, were thanked for the trouble they had taken and for the interesting entertainment provided.

The Western Union Telegraph Company and the Mexican System.—The Mexican papers now coming to hand are a little exercised about a rumour to the effect that a representative of the Western Union has arrived in Mexico for the purpose of proposing the purchase of the telegraph lines owned by the Government. The sway exercised by the Western Union over the commercial and journalistic interests of the United States is so complete that many American statesmen think that the telegraph lines of the United States should be taken charge of by the Government, and the *Two Republics* suggests that before considering any proposition from the Western Union, the company's past record and present position should be investigated. The paper quoted is of opinion that greater efficiency might be attained without a transfer of the lines from the Government to the corporation named; indeed, it is thought likely that an improvement of the federal system will be shortly brought about by the competition of the rivals which serve most of the principal cities of Mexico. All the railroads in Mexico own and operate telegraph lines, and besides these there are telegraph companies competing with the Government. At present there is no telegraph monopoly in Mexico, and it is argued that the interests of the public would be best served by opposing any attempt of one company to obtain entire control.

The National Telephone Company's Stand at the Dundee Trade Exhibition.—This exhibit includes specimens of the instrument and apparatus in practical use, from the subscribers' instrument to the switch table (for connecting subscribers together), attended by a trained operator. The stand is in connection with the company's Dundee exchanges, and from it conversation can be held with subscribers in Dundee, Broughty Ferry, Newport, Tayport, Monifieth, Perth, Forfar, Arbroath, Kirkcaldy, Dunfermline, Stirling, Bridge of Allan, Alloa, Falkirk, and Grangemouth, &c. Visitors to the Exhibition have heard by telephone the orchestra at Her Majesty's Theatre, and subscribers listen at their own fireside to the concerts taking place in the Exhibition. The call office attached to the stall has been largely taken advantage of, not only by subscribers, but also by the Exhibition authorities and the general public. Conversations to and from the Exhibition pass over the wires stretched on the standards at each end of the stall, and these wires and standards are typical of the system of overhouse construction introduced by Mr. A. R. Bennett, the company's general manager. The wire used in towns is of silicious bronze. On the table specimens of the various kinds and gauges of bronze copper and iron wire adapted to particular uses are shown. There is also a specimen of the submarine telephonic cable which crosses underneath the Tay, and of other cables in use in the district. Insulators of various patterns are shown. Of the apparatus various makes of magneto bells are prominent. These are fitted with the circuit key, adapting them for use with Mann's circuit wire system, which was first brought out in Dundee. This circuit wire system enables subscribers to speak to the operators independently of their direct wires, and is of the greatest advantage in securing promptness and certainty in the connection of subscriber to subscriber. Mr. Bennett's translator for enabling single wires in towns to be connected to inter-town loop wires without destroying the efficacy of the loops is also shown. An apparatus for automatically counting the number of messages passing through telephone exchanges (designed by Mr. Miller, manager of the company in Dundee) is shown in working order. An intermediate switch now extensively used by the National and other companies, a new form of circuit key, a disconnection signal for use on trunk lines, a table telephone set, and an arrangement to enable each operator in the telephone exchange to communicate instantly with any other operator without the aid of a third operator, for rendering the connection of subscribers more expeditious, all designed by Mr. Miller, are also to be seen. A pole changer, designed by Messrs. Brown and Jamieson for the purpose of ringing subscribers by the mere depression of a key by the operators, is worthy of notice. It forms an excellent "shocking" machine, and in this capacity has afforded much amusement to visitors, besides performing the real work required of it. A fire brigade alarm for fixture at street corners should also be mentioned. The breaking of the glass front instantly sounds an alarm at the fire station, and indicates whence the signal came. The receipt of the signal at the fire station is acknowledged by the word "coming" appearing on the face

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of the alarm in the street. The various sundries of telephone work, such as batteries, lightning arrestors, switches, indicators, &c., go to make up a highly interesting exhibit. A number of the appliances are made in the company's own workshops in Dundee and Edinburgh.

The St. James's Vestry and Electric Lighting.—The Lighting Committee of the Vestry of St. James's, Westminster, have had under their consideration the draft South Metropolitan Electric Lighting Order. While keeping in view the interests of the general body of probable consumers of electricity, and the rights of the public as preserved by the Vestry, the committee have paid particular attention to certain undue restrictions which they consider would affect prejudicially the interests of the consumers. The committee have recently reported at considerable length on the subject; and they state that some of the conditions which the undertakers seek to attach to a right to require a supply of electricity are "so onerous as to be almost prohibitory in character." For example, they propose that they shall not be compelled to supply electricity to any private consumer in a street where a main has not been laid, unless six or more persons agree to pay, for a period of three years, such a sum as will represent 20 per cent. per annum upon the cost of furnishing the supply. Another proposal is that a would-be consumer, after a main has been brought within 25 yards of his premises, must agree to pay a similar sum, representing 20 per cent., for two years. The committee say that if the company attempt to enforce such conditions as these to any large extent, the general introduction of electricity, for the purpose either of light or power, will be "relegated to the very distant future." The committee also think it their duty to point out that if, through the introduction of electricity, the large consumers withdraw, the gas mains will continue to be charged as at present; and it is evident that the area and cost of distribution would be proportionately increased as the length of unprofitable mains is extended. In this case, the price of gas would probably rise, and the increased cost fall upon the smaller and poorer consumers. Indeed, observe the committee, it is possible for the poorer locality to be deprived both of gas and electricity, for, under the provisions of the Electric Lighting Act, the Board of Trade may relieve a gas company of their obligation to supply gas in an area sufficiently supplied with the electric light, if gas lighting has become unremunerative; yet at the same time the price of electric lighting might be too great for small householders. The committee also consider that the capital of the undertakers—£250,000—is utterly inadequate to carry out the obligations of the order in so extended an area as that proposed; and they view with great disfavour any attempt to obtain a concession for the supply of electricity in a large district with insufficient capital, with the evident intention of subdividing it into sections each to be "floated" by the original undertakers. Many clauses are objected to by the committee; amongst others, Clause 43, by which the undertakers seek to impose a limit of 50 yards as the maximum distance of a public lamp from a main. The committee point out that gas companies have to supply such lamps at 75 yards distance; and the same distance should, they think, be fixed for lamps lighted by electricity. Copies of the report have been sent to the Board of Trade, to the Metropolitan Board of Works, and to the Parliamentary agents for the order.

Lecture on Electricity as a Motive Power.—Under the auspices of the Free Public Library Committee of the Leeds Corporation, a lecture was recently delivered by Prof. Stroud, of the Yorkshire College, on "Electricity as a Motive Power." Prof. Stroud, whose lecture was illustrated by means of the oxy-hydrogen light, and by interesting and very successful experiments, explained the various forms of motors, and remarked that at the present moment electricity could be produced by means of a dynamo machine at a cost somewhat under one penny per horse-power per hour, that being a reduction in the cost at which electrical currents were produced of one-fortieth as compared with twenty years ago. It seemed to him that electricity was specially applicable to locomotives. In the first place, electricity possessed the unique advantage of not requiring the motive agent to move with the conveyance. The horse preceded the carriage it was drawing—the locomotive the train. The average weight of a locomotive was about that of six carriages filled with people; ten carriages comprised an ordinary train, hence the presence of the locomotive added at least 50 per cent. to the horse power required to propel the train. Indeed, when they contemplated a steam engine the wonder was, not that it could draw carriages, but that it could move itself. But there was a more serious objection to the engines than that. As they had to pass over every part of the line, that necessitated the whole line and all the bridges being made many times as strong, and many times as costly, and the expense of maintenance was considerably greater than if there were no locomotive. As the traction was applied only to one pair of wheels, it was not possible to make the engine much lighter; otherwise the adhesion with the rails would not be sufficient to enable the locomotive to draw the train. The use of electricity would enable the power to be employed by every pair of wheels, the result of which would be, first, that it would save the permanent way from wear and tear; and second, it would enable the train to go round curves and along the line at very much greater speed, and with only a fraction of the present jolting. Possibly double the present speed would not be considered excessive for an electrical train. Furthermore, a train would be able to get up speed in a few seconds, instead of as many minutes. This followed from the principle of continuous brakes. With an ordinary train of ten carriages it took one minute to attain a speed of 30 miles per hour. If this motion was accelerated more rapidly the wheels would slip. But if power were applied to every wheel it would attain that velocity in six seconds, and with no more jerk than was now felt when a continuous brake was applied. If there were power enough a train could go up a steep hill, instead of being confined, as practically they were, to an incline of 1 in 80. An ordinary train slipped down an incline of 1 in 50 when the locomotive alone was braked. But when all the wheels were braked the train rested on an incline of 1 in 5. With the necessary power they could ascend an incline of 1 in 5 with electrical motors. As to cost, an ordinary railway line on the level costs £5,000 per mile; whereas, when there were tunnels, bridges, and embankments to build, the cost rose to £15,000 per mile. Now, the interest on the capital outlay of a railway was usually a far more serious matter than the working expenses. With electrical locomotives going up and down hill, the original outlay would be more than halved. The mayor had remarked that he hoped it would be possible to produce electrical currents much more cheaply than they could produce them at present. There was one great discovery yet to be made. They wanted an arrangement for converting heat directly into electricity without the intervention of the steam engine. Electricians were endeavouring to solve that difficulty, and when it was solved it would mean the abolition of the steam engine at once, and the steam engine would become, in fact, a relic of antiquity.

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A PROPOSED NEW PUBLIC TELEPHONE SYSTEM FOR CITIES AND LARGE TOWNS.

BY WALKER MOSELEY.

Electricians and others interested in the telephone question are aware that in three years the master patent rights expire. The telephone companies indulge in some hope that the patent rights will be renewed; but if they can make out a case in favour of renewal the twenty-second section of the 1883 Patents Act will have to be considered. It is as follows :—

COMPULSORY LICENSES.

Sec. 22. If, on the petition of any person interested, it is proved to the Board of Trade that by reason of the default of a patentee to grant licenses on reasonable terms—

(*a*) The patent is not being worked in the United Kingdom ; or,

(*b*) *The reasonable requirements of the public with respect to the invention cannot be supplied* ; or,

(*c*) Any person is prevented from working or using to the best advantage an invention of which he is possessed,

The Board may order the patentee to grant licenses on such terms as to the amount of royalties, security for payment, or otherwise, as the Board, having regard to the nature of the invention and the circumstances of the case, may deem just, and any such order may be enforced by mandamus.

If the Board should be convinced that the italicised words apply to the existing arrangements of the United Telephone Company's system, the compulsory license would be ordered in favour of any suitable applicant. But before any application of the kind would be necessary, the company must get an extension of term of patent right, and to do this they have to prove the following words of the fifth clause of the 25th section, viz., *the patentee has been inadequately remunerated.*

In any case, however, no legitimate interest can suffer from a thorough investigation at the present time into the ways and means for the immediate future of public telephony.

Four years ago the United Telephone Company sought to obtain, by a private Bill, parliamentary powers to enable them to lay wires underground or erect them overhead without asking leave of anybody. I wrote three letters on the subject, signed "Mos Legem Regit," which appeared in this journal, and either my criticism or other reasons caused them to abandon the Bill about a week or two after. The company now announce their intention to apply again for similar powers. What has transpired since then to change the situation? At their last general meeting the chairman explained how they had commenced a remodelling of their exchange system by the adoption of the American multiple switch-board. It is also well known that by the adoption of the "double-wire system" the Post Office electricians have demonstrated in Newcastle and elsewhere that the evils of induction may be quite eliminated. In New York they are so confident of the "double-wire system" that they have already spent £60,000 on the new multiple switch-board adapted to the system for the New York Central Exchange Room.

I put forward the following proposal because I think that the whole scheme would be better carried out *en bloc* than be added piecemeal to an imperfect system. In the endeavour to rivet attention, my preliminary explanation of certain details may not appear sufficient to commend the whole scheme, but as in succeeding papers I shall have to return to the salient points for closer examination and illustration of details, I trust the present sketch will meet with a certain amount of indulgence. But meanwhile I can promise that I have grappled with every practical difficulty, and I shall fearlessly challenge any criticism of the means I have devised to overcome them. I now proceed without further preface to explain the details of my method as adapted to the requirements of the Metropolitan district.

The diagram (Fig. 1) is formed to suit the geographical and commercial disposition of the various sections of London. The letters A B represent respectively the Bank and Piccadilly-circus. The straight thick line is the inmost line of route for wires leading east and west to the central exchange, to be established somewhere in the neighbourhood of Lincoln's Inn-fields or Covent Garden Market. The surrounding endless lines and the radial and rectangular lines complete a system of arterial conduits for leading wires to every part of London within an area of six miles by three. These conduits I propose to fix along the fronts of buildings and existing lines of streets as far as practicable, and as a rule at a height of about twenty-five feet from the ground. Of course, thus far the plan proposed might be rejected as commercially impracticable without obtaining certain powers by Act of Parliament; but that shall be discussed later on. It will be seen that in any area within the outer circle about four out of five of the renters would be connected with the arterial system by an aerial line not requiring *any intermediate support*, and none of them would require more than *one* intermediate support. The difficulty of obtaining way-leaves, and the hitherto serious delay in getting connected with the Exchange system would consequently disappear. The same facilities would enable any one to have a private wire at short notice. The Central Exchange I propose to be limited to five thousand renters as a maximum not likely to need extension for many years to come. For auxiliary exchanges I propose to set up one at each of the intersections on the outer circle, say 40 in all, with a capacity at the outset for about 100 or of 150 to each.

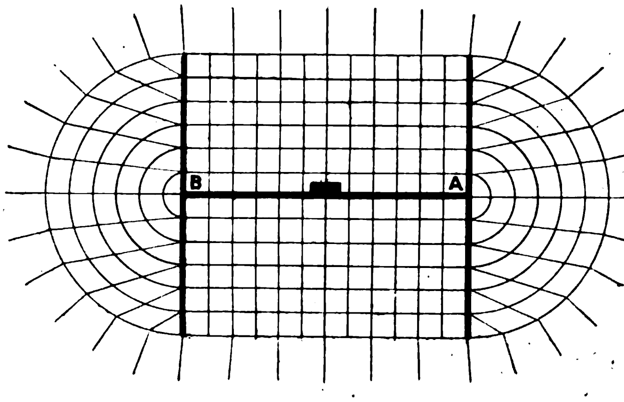

FIG. 1.

The renters connected to the Central Exchange would form a separate group from those connected to the Auxiliary Exchange, not determined by their locality, but by the frequency with which they use the telephone. A central exchange with switch-boards fitted on the multiple system would be most serviceable to renters who have most use for the telephone and whose time is most valuable. This group would pay, say, £20 per annum, but the remainder would pay only £10. It may be that the alternative could not be fairly made a matter of choice on the renters' side only, but this would be determined by considerations that would involve too much detail for present purposes. As regards "call rooms" for the use of the general public on a small fee for each conversation, it will be obvious that the system described thus far would facilitate their multiplication as required. Beyond the outer circle I propose that radiating lines of route shall be chosen for leading conduits to populous districts, and that these conduits shall be fed from aerial lines.

Before entering further into detail I will refer briefly to the advantages to be derived from the plan sketched out. Four years ago the United Telephone Company informed their shareholders at a general meeting (*Electrician*, February 23, 1884) that "if you put a telephone wire under the earth you diminish its value by fifteen times out of sixteen." The significance of this declaration lies in the fact that nothing is known now in opposition to it that was not known at the time it was uttered as the reason why the company could not consent to fall in with the public feeling against overhead wires. Public telegraphy had been carried out successfully and economically throughout Germany for *twenty years* almost entirely with underground wires, but the results of tentative telephony through underground wires were so discouraging that the principal telephone companies felt justified in condemning underground wires without ascertaining how much the failures

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were due to induction and how much to leakage. Nevertheless, it may be assumed that the companies are now prepared to admit that underground wires *can* be insulated well enough to prevent serious leakage, and that by the adoption of the double-wire system—or in other words a complete metallic circuit—the evil effects of induction can be obviated. Still it is quite intelligible that from a commercial point of view (a short-sighted view, possibly) it would have been very hazardous to have incurred the great expense until it could be no longer avoided. The United Telephone Company summed up the question in a circular to their shareholders, Feb. 14, 1884, thus—"It is uncertain whether the result to telephonic communication would be so satisfactory, and certainly the cost would be so large as entirely to prevent one of the objects of the company, viz., to give a cheap telephonic communication to the whole of London." In 1880 I pointed out in the columns of *The Electrician* that good and permanent insulation was too important to let a timid temporary economy stand in the way of sound work at an adequate outlay. If, therefore, the system I have sketched out can be shown to meet the three difficulties hitherto insuperable, it will be worth while to consider carefully the principal details. The three difficulties may be briefly termed

1. To secure insulation;
2. To kill induction;
3. To install and maintain economically.

The mischievous nature of faulty insulation is now fully admitted. I myself went very fully into this subject in some papers on "Electric Bells" which appeared in the columns of *The Electrician* in 1880, and also under the head of "Fire Risks from Electric Lighting," in 1882. These considerations make it clear how much more the faults of "stray talk" on contiguous lines must be due to leakage rather than to induction. Bad insulation, everybody admits, is remediable; but induction has been generally spoken of as inevitable, and the *bête noir* of telephony. Both faults have been multiplied, as a rule, where underground wires have been used; hence the opinions and the policy of the United Telephone Company. It has been fully proved within recent years, however, that two well insulated lines running close together may be used as a complete metallic circuit without any induction from adjoining wires being observed, hence it has been assumed that nothing need prevent the immediate adoption of underground routes. But faulty insulation turns out, after all, the *real bête noir*, and the adoption of a complete metallic circuit would, *cæteris paribus*, only increase the old evil. My remedy essentially and practically is to take up and extend the method described in *The Electrician* of May 29, 1880, on page 19, which secures perfect insulation wherever adopted. This method I have since improved by a system of making joints that will admit of instant access for tests and alterations, which vastly increases the practical value of the system.

Before going into further detail on this head, let me endeavour to remove objections that some may regard as standing on the very threshold, and hence demanding first consideration, viz., the questions of right and sightliness involved in proposing to fix the conduits on the fronts of houses along streets. The nearest existing approximation to what is required may be seen on some of the large and handsomely-fitted Atlantic steamers. Walking along the passages between the state rooms everything looks neat and perfectly orthodox in all the details of wood and metal ornament. One of the members, however, of the moulding forming a minor cornice is in reality a tube containing wires, and here and there are ornamental trusses, which being hollow, the removal of two screws allows one to come away and exposes the sockets containing the wire junctions, the wires in which may be instantly tested and the truss as quickly replaced. Equal neatness and sightliness may not be practicable along street frontages, but comparing the effects obtainable by a slight variation of altitude and architectural sham trusses with the present obtrusive ugliness of imitation clothes lines decorated with old paper kites, dead leaves, &c., the choice would be greatly in favour of the new scheme.

As regards the question of compulsory powers by Act of Parliament, which would be required before the owners would allow a 2in. tube to be fixed across their house fronts, it would not be less reasonable than several other restrictions where consent is equally compulsory by existing Acts of Parliament; and if it were a mere choice between crossing one's front by a simple tube or stopping trade by impeding traffic to put wires underground, as well as for frequent repairs, the former would be accepted as the lesser evil.

At the same time I believe it can be made clear that no legitimate interests of private owners would be injured or ignored.

If equal public advantages can be secured by some other plan it is desirable in the interests of all concerned that it should now be made known, but, if not, the few private owners who will be practically or theoretically affected will see that the proposals I shall make for a scale of compensation for right of fixture when taken in connection with a preferential option of being connected to the system at a great reduction of subscription will leave no room for the creation of any grievance.

(*To be continued.*)

NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

(*Continued from page 286.*)

We proceed to examine the principles underlying the simplest case of alternate or periodic current flow in a linear conductor. Let there be any conductor, such as a wire, of which the cross section is very small, and let this be formed into a coil of many turns and subjected to a simple periodic electromotive force, called hereafter the *impressed electromotive force*, the periodicity being not greater than about 200-300 per second. It is required to find the current at any instant in the wire. The minds of many electrical students, who have been educated too much or too exclusively by contact with continuous currents, are apt to imagine that the simple and familiar law of Ohm is all that is required to meet this case. The supposition is, however, wrong, and the deduction would be found to be disappointed in practice. Every circuit possesses two qualities, which determines the current when it is subjected to a simple periodic electromotive force of given periodicity. These are its *inductance* and its *resistance*. The resistance of a conductor is a quality in virtue of which the passage of a current through it is accompanied by the dissipation of energy—that is, by the irreversible transformation of electric-energy into heat. The inductance of a circuit is a quality in virtue of which the passage of an electric current through it is accompanied by the storage of energy in the form of a magnetic-field. Of the expended energy spent on a conductor (assuming no performance of chemical or external mechanical work) part fritters away into heat by an irreversible process, and part is associated with the circuit in a recoverable form, and is taken up in the establishment of the energy of the magnetic-field, which starts into existence round the conductor. This potential energy, however, dissipates itself as soon as the impressed electromotive force is withdrawn. A mechanical analogy to the operation of starting a current in a wire may be found in the operation of starting from rest, or increasing the speed of a heavy fly-wheel which runs in bearings with friction. On applying a twisting force to the axle of the wheel we get up its speed. To maintain the speed force has to be continually applied, and the work so done against friction is frittered away irreversibly into heat in the bearings. The friction is analogous to the electrical resistance; it may be called the frictional resistance.

When the speed of the wheel is constant there is, however, associated with the wheel a certain quantity of energy in a kinetic form measured by $\frac{1}{2} I \omega^2$, where I is the moment of inertia, and ω the angular velocity of the wheel. As soon as the maintaining force is withdrawn this accumulated energy

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dissipates itself in heat by friction, or is utilised in some other way. During the time that the speed of the wheel is being increased, force must be applied to it for two purposes. First to increase the angular momentum, and secondly to overcome the friction at the bearings. Suppose that instead of revolving on bearings with friction, the fly-wheel revolves in a more or less viscous fluid, and that the bearings are truly frictionless. In such case the frictional resistance to motion would be fluid resistance, and would for low speeds be approximately proportional to the angular velocity. If I is the moment of inertia and ω the angular velocity of the wheel at any instant, then it is shown in treatises on dynamics that $I\frac{d\omega}{dt}$ is at any instant a measure of the couple or twisting force acting on the wheel to increase its angular velocity, friction being neglected. If we call the friction coefficient B, then $B\omega$ is at any instant the measure of the force necessary to maintain the motion against friction, and the total torsional or twisting force acting on the wheel to maintain its angular velocity against the force of friction, and to increase it against the force of inertia, is

$$F = B\omega + I\frac{d\omega}{dt}.$$

A precisely similar equation may be found connecting the electromotive force, current resistance, electrical and inductance in the case of current starting in a wire. The above equation gives us a value for the instantaneous angular velocity, or enables us to find the angular velocity after any time when F, B, and I are given. When a current of strength i is flowing steadily in a linear conductor, such as the wire under consideration, the energy associated with it in the form of a magnetic field is measured by the quantity $\frac{1}{2}Li^2$, where L is the quantity called the inductance of the circuit. Since this quantity L bears to electro-magnetic energy a relation similar to that which the moment of inertia of a wheel does to the energy of its rotation, it might be called the coefficient of electro-magnetic inertia; but as this would be a cumbersome name, it has been called the inductance, or more frequently the self-induction of the circuit. Similarly the product of the moment of inertia and the angular velocity of the wheel is called the angular momentum, and analogously the product of the inductance of a circuit and the current flowing at that instant through it is called the electromagnetic momentum. The rate at which the angular momentum of a wheel is increasing or diminishing at any instant is a measure of the rotational force, or the couple acting on it at that instant. So also the rate of change of the electro-magnetic momentum of a circuit is the measure of the electromotive force acting on it as far as mere change of current strength is concerned, and omitting, for the present, that part of the electromotive force required to overcome the Ohmic resistance. We have, then, the following parallel between a fly-wheel, with moment of inertia I, revolving frictionlessly and having an angular velocity ω at any instant, and an electric circuit of inductance L, having a current of strength i flowing in it at any instant:—

Angular kinetic energy of the wheel, or energy of rotation	=	$\frac{1}{2}I\omega^2$
Electro-magnetic energy of the circuit	=	$\frac{1}{2}Li^2$
Angular momentum of wheel	=	$I\omega$
Electro-magnetic momentum of the circuit	=	Li
Rate of change of angular momentum of wheel = couple or torsional force causing rotation......	=	$I\frac{d\omega}{dt}$
Rate of change of electro-magnetic momentum = electromotive force employed in changing current strength	=	$L\frac{di}{dt}$

In the electric circuit, over and above the electromotive force which is, so to speak, used up in changing electro-magnetic momentum, there is an amount required to overcome the frictional resistance of the wire, and which, as it is defined and measured by Ohm's law $E = Ri$, may be called the Ohmic resistance. Hence, at any instance if E is the impressed electromotive force acting on the circuit and causing a current i, we may divide E into two parts, one part equal to Ri by Ohm's law, which is sometimes called the effective electromotive force, and another part $L\frac{di}{dt}$, which is the part operating to change the strength of the current, at that instant, producing a small change, di, in the current strength i in a time dt.

Hence
$$E = Ri + L\frac{di}{dt}.$$

This is the fundamental equation for varying or periodic currents, when the periodicity is not so rapid as to affect the uniform distribution of the current over the cross section of the wire, and when the electrostatic capacity may be neglected. The part $L\frac{di}{dt}$ is often called the counter-electromotive force of self-induction, and the above equation might be read in words—

$$\text{Impressed E.M.F.} = \text{Effective E.M.F.} + \text{Counter E.M.F. of self-induction.}$$

We might otherwise arrive at this fundamental equation thus: The total rate of expenditure of energy in a circuit is at any instant measured by the product of the current at that instant existing in the wire and the difference of potential between its ends. The energy expended in the circuit is at any instant being partly dissipated at a rate equal to Ri^2, R being Ohmic resistance, and i current, and partly being stored up in the field at a *rate* equal to $\frac{d}{dt}\left(\frac{1}{2}Li^2\right)$. Hence we have:—

$$\text{Rate of supply of energy} = \text{Rate of dissipation of energy as heat} + \text{Rate of absorption or storage of energy as magnetic field.}$$

and this in symbols is—

$$Ei = Ri^2 + \frac{d}{dt}\left(\frac{1}{2}Li^2\right)$$

or

$$E = Ri + L\frac{di}{dt},$$

which is our fundamental equation.

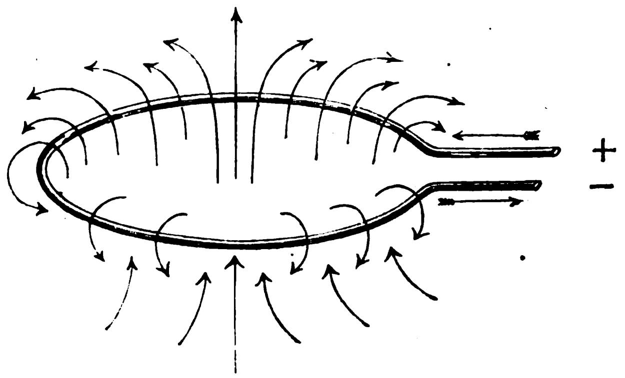

Fig. 18.

We may interpret this equation by looking at it from the point of view of Faraday rather than Clerk Maxwell. When a current is flowing in a conductor, we may picture it as surrounded by its lines of electro-magnetic force *properly* mapped out. That is so that the number of the lines of force passing perpendicularly through a unit of area taken at any point in field is equal to the numerical value of the mean strength of magnetic field over that area. If the circuit has the form of a loop (Fig. 18) lying on a horizontal plane, with the current circulating round it in the opposite direction as the hands of a watch rotate, then the lines of force must be considered as springing out from the upper surface, and turning outwards and over the conductor, so as to re-enter the loop from the under surface. The closed circuit is therefore linked with a certain number of lines of force, which, if the circuit is composed of non-magnetic material, are proportional

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in number to the strength of the current at that instant. Any increase in strength of the current causes more lines of force to grow out from the circuit, and packs the loop fuller of lines of force. By Faraday's law, any increase of the number of lines of force traversing or linked with a circuit creates an induced electromotive force numerically equal to the rate of increase of that number at that instant. Hence, if 100 million lines of force—C.-G.-S. measure—are put or inserted at a uniform rate in one second into a circuit, it will create an induced E.M F. of one volt in it. But if lines of force are thrust into a circuit the direction of the current induced is counter clock-wise, as seen from that side of the circuit at which they are thrust in (*see* Fig. 19).

Applying this to the case of self-induction, it is easily seen that any increase of current strength in the circuit in Fig. 18 crowds the space with more lines of force, and therefore creates in it an electromotive force of self-induction opposed to the impressed electromotive force which is acting to increase the current, and as long as the current is increasing this counter E.M.F. is at each instant proportional to the rate of growth of the current strength.

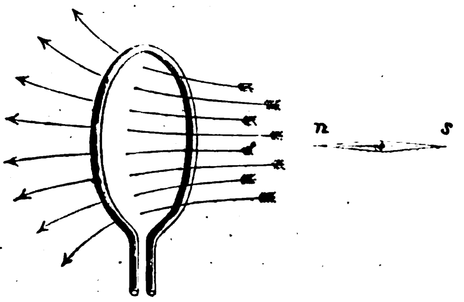

Fig. 19.

Lines of force being crowded into a circuit, inducing a counter clock-wise E.M.F., as seen from the side at which they are put in.

We can cast our current equation—

$$E = R\,i + L\frac{d\,i}{d\,t}$$

into another form, thus :—

$$\frac{E}{R} - i = \frac{L}{R}\frac{d\,i}{d\,t},$$

where $\frac{E}{R}$ is the maximum value which the current can attain, let us call this I; the quantity $\frac{L}{R}$, or the ratio of the inductance to the resistance of the circuit, is called the *time constant* of the circuit; let this quantity be denoted by T. We then have

$$I - i = T\frac{d\,i}{d\,t},$$

which, in words, is a statement that if a steady E.M.F. is made to act on any circuit whose time constant is T, the amount by which at any instant the current falls short of its full value is equal to its rate of growth at that instant, multiplied by the time constant.

(*To be continued.*)

CABLE TESTING.—THE FALSE ZERO METHOD.

BY M. EMILE LACOINE.*

This method is well known to all electricians who have to do with cable testing, but it appears to me that a misapprehension exists in the minds of most of those who have written on the subject. Take as an example the description in the admirable "Pocket-Book of Electrical Books and Tables," by Munro and Jamieson (p. 141, second edition), which is as follows :—

"1. Join up as in figure, and obtain 'false zero,' *i.e.*, the deflection on galvanometer G, due to cable or earth currents [call this deflection D]. This is done by inserting a resistance, R, *equal to the battery resistance* between centre of bridge at 3 and earth (Fig. 1); the battery B being out of circuit, the earth-current flows on, depressing K_2 partly through galvanometer to earth [and in part it traverses the resistance *d*, which is already approximately adjusted to *c*].

"2. Cut R out of circuit, and apply + or − pole of battery B, by key K_1, adjusting the resistance *d* to the 'false zero' [so as to reproduce the deflection D].

We have then $c = d \cdot \frac{a}{b}$ for the resistance sought."

The usefulness of the method is, however, much impaired by the supposed necessity for knowing the resistance of the battery, which involves a preliminary test; but is it really necessary to make the resistance R equal to that of the battery? I have made a great use of the method, and in practice, I have never found that this is necessary.

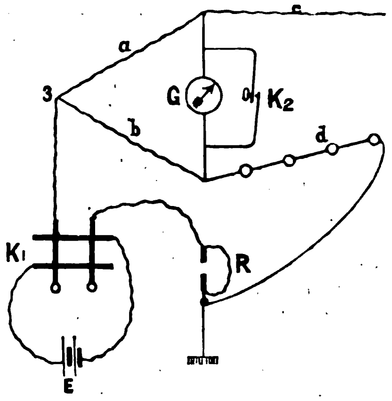

Fig. 1.

Even so high an authority as Mr. Kempe is, however, under the impression that the theory of the test requires this condition, and in his standard work on "Electrical Testing," he gives a proof in which this condition is assumed. I shall therefore show, mathematically, that this resistance may be entirely dispensed with.

This result follows at once as a consequence of the general law of Dr. Frölich (see *Wied. Ann.*, Vol. XXX., No. 1, 1887). It can also easily be proved by the following simple application of Kirchhoff's laws :—

Fig. 2 is a diagram of the first operation in which the battery is out of circuit, and any resistance whatever (*p*′)

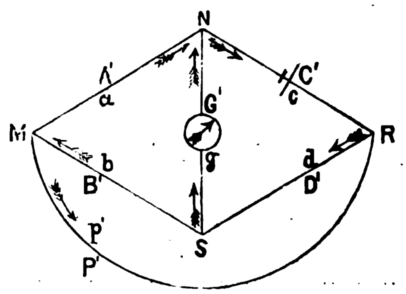

Fig. 2.

occupies its place. [The cell in the branch C represents, of course, the "earth current" in the actual test.] Fig. 3 represents the second operation with the battery of resistance *p* in circuit. The italic letters represent the resistances which, save *p*, are invariable. The capital letters with accents represent the currents in Fig. 2, and those without accents represent the currents in Fig. 3. *a* and *b* are the ratio arms of the bridge, and *d* the adjustable resistance.

We have, according to the law of Kirchhoff (Fig 3),

$$A\,a - G\,g + B\,b = 0,$$

and similarly, in Fig. 2,

$$A'\,a - G'\,g + B'\,b = 0.$$

* From the *Journal Télégraphique*, 25 January, 1888 (p. 12).

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And as G = G′ we get

$$\mathrm{A}a+\mathrm{B}b=\mathrm{A}'a+\mathrm{B}'b.$$

But we have also

$$\mathrm{B}=\mathrm{A}+\mathrm{P} \quad \text{and} \quad \mathrm{B}'=\mathrm{A}'+\mathrm{P}';$$

whence, replacing B and B′,

$$\mathrm{A}a+\mathrm{A}b+\mathrm{P}b=\mathrm{A}'a+\mathrm{A}'b+\mathrm{P}'b$$

$$\mathrm{A}a-\mathrm{A}'a+\mathrm{A}b-\mathrm{A}'b=\mathrm{P}'b-\mathrm{P}b$$

or

$$(\mathrm{A}-\mathrm{A}')(a+b)=b(\mathrm{P}'-\mathrm{P}). \quad (1).$$

In the circuit N R S, we have similarly

$$\mathrm{C}c+\mathrm{D}d+\mathrm{G}g=e \qquad \mathrm{C}'c+\mathrm{D}'d+\mathrm{G}'g=e;$$

whence, as before,

$$\mathrm{C}c+\mathrm{D}d=\mathrm{C}'c+\mathrm{D}'d.$$

But we have also

$$\mathrm{D}=c+\mathrm{P} \quad \text{and} \quad \mathrm{D}'=c'+\mathrm{P}';$$

whence, replacing D and D′,

$$\mathrm{C}c+\mathrm{C}d+\mathrm{P}d=\mathrm{C}'c+\mathrm{C}'d+\mathrm{P}'d$$

$$\mathrm{C}c-\mathrm{C}'c+\mathrm{C}d-\mathrm{C}'d=\mathrm{P}'d-\mathrm{P}d,$$

or

$$(\mathrm{C}-\mathrm{C}')(c+d)=d(\mathrm{P}'-\mathrm{P}). \quad (2).$$

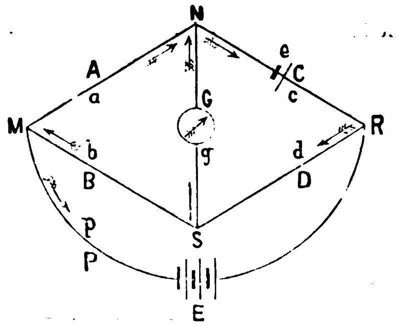

FIG. 3.

Dividing equation (1) by (2) we have

$$\frac{(\mathrm{A}-\mathrm{A}')(a+b)}{(\mathrm{C}-\mathrm{C}')(c+d)}=\frac{b}{d}. \quad (3).$$

But we have again

$$\mathrm{A}+\mathrm{G}=\mathrm{C},$$

$$\mathrm{A}'+\mathrm{G}'=\mathrm{C}'.$$

By subtraction

$$(\mathrm{A}-\mathrm{A}')=(\mathrm{C}-\mathrm{C}').$$

So that equation (3) reduces to

$$\frac{a+b}{c+a}=\frac{b}{d};$$

whence we have, lastly,

$$c=d\cdot\frac{a}{b}.$$

We see then that the value of c is not only independent of the E.M.F. of the battery, but also of its resistance and of the substituted resistance p', which may be anything we please. Therefore, an auxiliary resistance is useless, and we may short-circuit this branch altogether.

We may even open this branch without affecting the conditions; we then return to the well-known method of Mance for measuring the internal resistance of a cell. It will be seen at once that if in formulæ (1) and (2) we make P′ = 0, we arrive at the same values in (3) as before.

BOOKS RECEIVED.

"L'Année Electrique." By M. PH. DELAHAYE. (Paris: MM. Bawdry et Cie. 1888.) (Fourth year of publication.)

"Journal of the Society of Telegraph-Engineers and Electricians;" Vol. XVI., No. 69. (London: E. and F. N. Spon. Price Two shillings. 1887.)

MEETINGS OF SCIENTIFIC SOCIETIES.

TO-NIGHT (FRIDAY), February 3rd.

INSTITUTION OF MECHANICAL ENGINEERS.

7.30 p.m. Meeting.

ROYAL INSTITUTION.

9 p.m. Lecture, "Ancient Microscopes." By Mr. FRANK CRISP.

SATURDAY, February 4th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Experimental Optics" (3). By Lord RAYLEIGH.

MONDAY, February 6th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II. "Yeast, its Morphology and Culture." By Mr. A. GORDON SALOMON, F.C.S., F.I.C.

SOCIETY OF ENGINEERS.

7.30 p.m. The First Ordinary Meeting for the year 1888, at the Town Hall, Westminster. The President for the past year, Professor HENRY ROBINSON, will present the Premiums awarded for Papers read during the year; and the President for the year 1888, Mr. ARTHUR T. WALMISLEY, will deliver his Inaugural Address.

INVENTORS' INSTITUTE.

8 p.m. Ordinary Meeting.

TUESDAY, February 7th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper, "The Alexandra Dock, Hull. By Mr. A. C. HURTZIG, M.I.C.E.

SOCIETY OF ARTS.

8 p.m. Foreign and Colonial Section. "British Columbia." By HENRY COPPINGER BEETON, Agent-General for British Columbia.

ROYAL INSTITUTION.

3 p.m. Lecture, "Before and After Darwin" (4). By Mr. G. J. ROMANES, M.A., &c.

ROYAL VICTORIA HALL (Waterloo Bridge-road, S.E.).

Lecture, "Germs in the Air, and What They Do for Us." By Dr. PERCY F. FRANKLAND, B.Sc., F.C.S. Chairman, Sir GEO. YOUNG.

WEDNESDAY, February 8th.

SOCIETY OF ARTS.

8 p.m. Ninth Ordinary Meeting. "The Continuation of Elementary Education." By Mr. W. LANT CARPENTER, B.A. The Right Hon. Sir LYON PLAYFAIR, K.C.B., M.P., F.R.S., will preside.

THURSDAY, February 9th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Early Secular Choral Music" (1). By Prof. C. H. H. PARRY.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

8 p.m. Ordinary Meeting. "Alternate Current Transformers, with special reference to the best Proportion between Iron and Copper." By Mr. GISBERT KAPP., A.M.I.C.E., Member.

ROYAL SOCIETY.

4.30 p.m. Ordinary Meeting.

SOCIETY OF ARTS.

8 p.m. Special Lecture, "Etching and Mezzotint Engraving." By Prof. HUBERT HERKOMER, A.R.A.

FRIDAY, February 10th.

ROYAL INSTITUTION.

9 p.m. Discourse on "Safety Lamps in Collieries." By Mr. W. H. PREECE, F.R.S., M.R.I.

INSTITUTION OF CIVIL ENGINEERS.

7.30 p.m. Supplemental Meeting for Students. Paper, "Arched Ribs and Voussoir Arches." By Mr. H. MEDWAY MARTIN, Wh. Sc., Stud. Inst. C.E.

PHYSICAL SOCIETY OF GLASGOW UNIVERSITY.

"Apparatus for Determining the Horizontal Component of the Earth's Magnetism." By Mr. T. GRAY, B.Sc., &c.

SOCIETY OF ARTS.

8 p.m. Indian Section. "The Work of the Afghan Frontier Commission." By Captain MANIFOLD, R.A. Mr. J. M. MACLEAN, M.P., will preside.

SATURDAY, February 11th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Experimental Optics" (4). By Lord RAYLEIGH.

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ANSWERS TO CORRESPONDENTS.

R. BISHOP (Colchester).—*We regret that we cannot undertake to inform you which is the best engine, or dynamo, or battery, nor which is the best firm to whom to apply. Any respectable firm of electrical engineers would, however, be perfectly well able to satisfy your requirements.*

J. W. C.—*The following are some of the public institutions in the metropolis which are now provided with electric light; the list is short and perhaps incomplete:—The Houses of Parliament (in part), The British Museum, South Kensington Museum, The New Law Courts, Bethnal Green Museum, The General Post Office (in part).*

THE POSTMASTER-GENERAL AND THE TELEPHONES.

Although the speech made by the POSTMASTER-GENERAL in reply to a deputation from the Wolverhampton Chamber of Commerce last Friday was in every way unsensational and even commonplace, that portion of it which related to telephonic business has evidently created a good deal of excitement among dealers in telephone shares. According to one financial authority, Mr. RAIKES' words, if they had been first dropped in Capel-court, would have been worth to him a cheque for a good round sum. The plain meaning of this mysterious remark is that the declaration he was about to make would certainly send up the price of telephone property, and that his evident indifference to the consequences which have actually followed provokes some surprise in financial circles. Probably the consequences were inevitable, no matter how long the announcement might have been delayed, and perhaps the POSTMASTER-GENERAL had excellent reasons for thinking that the sooner it was made, and the disturbance occasioned by it abated, the better it would be for the shareholders. They are now in possession of a pretty distinct declaration of policy on the part of the Post Office, and have ample time to regulate their conduct accordingly. But there is nothing remarkable in the declaration itself. It might have been foreseen many years ago, and has certainly been growing imminent year by year. But to infer from what has now transpired that the telephone companies will gain by the Post Office acting on the line of policy thus indicated more than by carrying on their own business as heretofore seems to us somewhat rash. The words of the POSTMASTER-GENERAL do not warrant such an inference, the circumstances of the case do not justify it, and the recent negotiations between the Post

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Office and the submarine cable companies do not at all encourage it.

If he has been correctly reported, Mr. RAIKES simply deprecated the competition of private companies with the Post Office for telephone business, and predicted that before long telephony in this country must be placed on the same footing as telegraphy. Readers of these pages will be quite familiar with the view here enunciated; but with a slight verbal difference. As a matter of fact, there is no competition between the parties. What Mr. RAIKES, therefore, seems to object to is the absorption by private companies of business which he regards as rightly belonging to the Post Office. Mr. RAIKES is not responsible for the state of affairs, which has grown out of the compromise following on the great lawsuit between the Post Office and the original company; and he is free to state in effect that the arrangement was from the very first unlikely to assume a permanent character. On the part of the Post Office there is virtually no competition at all; and, except in one or two isolated places, the department has had no opportunity of showing the public what the telephone is capable of if taken in hand solely in the public interest and not as a commercial speculation. Obviously the State can never risk public money by competition in the ordinary business sense of the term; and in this particular case the Post Office was utterly disabled from doing so by the fact that it accepted a royalty on the business of all its possible competitors. To take the royalty and try to acquire the earnings would have been in the highest degree unfair; and the result has been that the companies have had a free hand, hampered only by the condition that, for depriving the Post Office of what the law had declared to be its legitimate business, a portion of their receipts should be handed over to the public revenue. Naturally, the original concession and its obligation have come to be quite forgotten, and for some time past the royalty paid to the Post Office has been denounced as a tax on telephonic enterprise; and the public usually take the view that the Government does its utmost to check the growth of telephonic business by increasing its necessary charges because of the royalty.

Now, if there is much ground for this contention—and undoubtedly there is some—it furnishes a most excellent reason for putting an end to the bargain. To a certain extent the customers have to pay for a double profit, the profit earned by the company and the unearned profit legally accruing to the Post Office. This is not only wasteful but exasperating, and when it is added that for every shortcoming of the service excuses are pleaded which directly or indirectly fix the blame on the Government, and tend to lower the standard of telephonic efficiency all round, it is plain that a state of things has been reached which amply explains the dissatisfaction with which it is viewed by the POSTMASTER-GENERAL. Nor is this all; representing a public department directly responsible for the telegraphs of the country and morally responsible also for its telephones—a responsibility incurred by the acceptance of telephone royalties, he naturally looks with disfavour on the growth of a vast monopoly associated with, but independent of, his department—a monopoly over which he has absolutely no control, but for the conduct of which he is constantly called to account. Our readers will acquit us of using the term monopoly in any offensive sense, and we have certainly no specific objections to urge against the monopoly freely conceded to, and fairly worked by, the parent telephone company. But its exclusive rights have confessedly not led to a very rapid popularisation of the telephonic system as a means of social and commercial intercourse. And this fact must be especially galling to the head of the Post Office, who is as much crippled in the matter as the meanest of Her Majesty's subjects. It may not be generally known, but the Post Office have reserved no rights in the telephone for themselves, and are sharply watched—so we are credibly informed—in every petty detail of the instrument, besides being forced to pay the market price for what the department could manufacture quite as well for itself and much cheaper. Interpreted into plainer language, what the POSTMASTER-GENERAL means is, we suspect, that, not the competition, but the monopoly of these private companies is "unsatisfactory."

If the position of the Post Office, unable to serve the public in its own way and powerless to influence the companies in any way whatever, has thus become almost intolerable, that of the companies is hardly less so. Their future is extremely uncertain, both in respect to the patents on which their existence largely depends, and the strained relations which are said to have long subsisted between the owners and the Government. Not only this, their system of overhead wires in populous towns is growing more and more objectionable with the extension of business, and a vast outlay on some scheme of reorganisation may soon be imperative. Moreover, the prospects of legislation favourable to an extension of their rights in this direction are, we believe, farther off than ever. It would rather surprise us if, as a contemporary ventures to predict, a "Postal Telephone Bill" were introduced in the coming Session; but under present circumstances the passing of the Bill for enlarging the powers of the telephone companies would surprise us still more. It is not the fact, as asserted by the same journal, that our telephone system is inferior to that of every country in the world. On the contrary, it is in all respects superior to that of every country in Europe; and in point of cheapness is not inferior to the American system. But somehow or other the English telephone companies have not made friends in or out of Parliament. They have always seemed to be working on for very life, making sure of their footing in order to establish a permanent right to existence; and this with often too little regard for public sentiment, safety, or convenience. This is not the time to blame them for what they have done or neglected to do. Their tenure has been precarious and anomalous from the very first, the chief persons in fault being those advisers of the then Government who, after fighting a legal battle, were at the same time too timid to seize the spoils of victory, and not magnanimous enough to abandon the indemnity. It has all along been evident that this "unsatisfactory" arrangement must one day come to an end. But we do not attach much immediate significance to the POSTMASTER-GENERAL'S words; and we by no means share the sanguine expectations which seem to be indicated by a general rise in telephone shares. Until something is heard about the terms on which telephones are to be "placed on the same footing as telegraphs" there will be nothing to warrant any unnatural fluctuation in the price of telephone shares.

DYNAMOS WITH INTERNAL POLES.

In our recent review of the progress of electrical engineering during the past year we referred to the fact that in Germany no less than four manufacturers have taken to the construction of dynamos with internal poles. Messrs. Siemens and Halske, Messrs. Ganz and Co., the Helios Company, and Mr. Fein are now producing machines of this type. The machine which we illustrate herewith is built by the latter maker. It does not at first sight seem very clear that the advantages obtained are sufficient to counterbalance the ob-

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jections to an overhung armature and the mechanical difficulties of winding the coils.

The machine illustrated in Fig. 1 is intended for an output of 15,000 watts when driven at 520 revolutions per minute, and its total weight is only 14½cwt. The weight of copper on the armature is 39lb.; that on the four magnet cores, which are arranged as shown in the sketch, Fig. 2, is 158lb. The resistance of the armature is ·052 ohm. The machine is compound wound, and the resistance of the main circuit—that is, of the four main exciting coils coupled in parallel, is ·023 ohm; that of the shunt circuit, 28 ohms. The current is 136 amperes, and the terminal pressure 110 volts. The inner diameter of the armature when wound is 19⅝in., the external diameter is 25in., and the length 6½in. The core consists of two hundred soft iron discs, insulated with paper, and mounted on and supported by twelve insulated bolts. This core is wound with one layer of square wire in 576 turns, connected Gramme fashion with a large commutator containing ninety-six parts. The field-

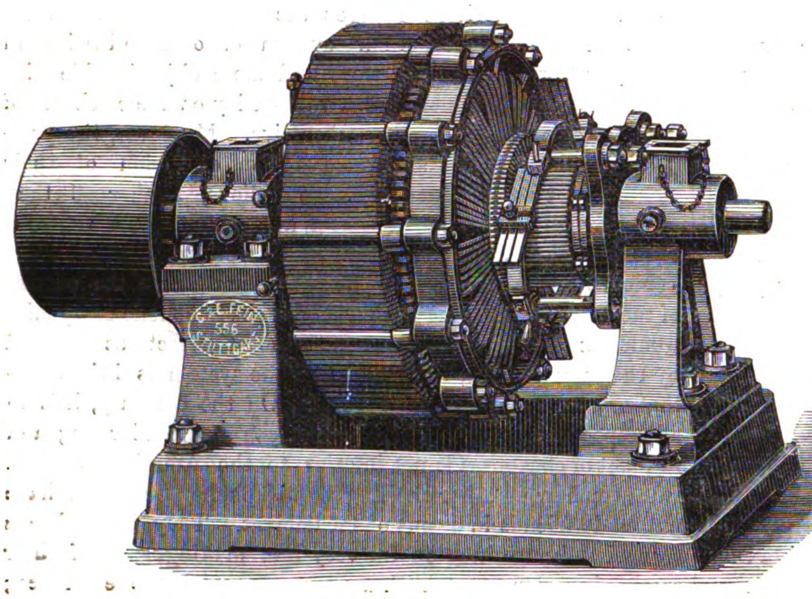

Fig. 1.

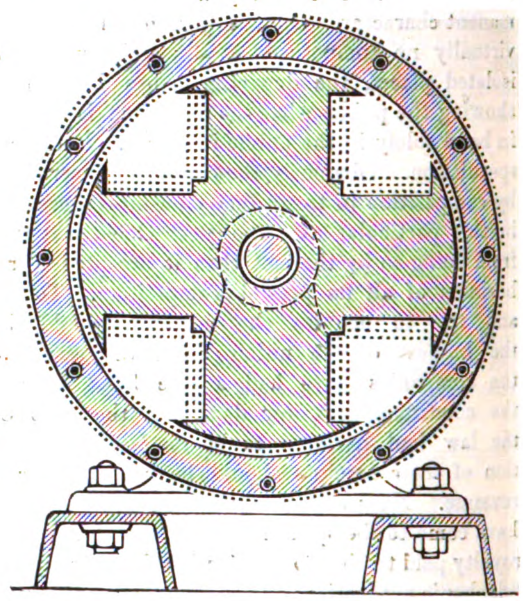

Fig. 2.

magnet cores are square, with rounded corners, each being wound with seventy-two turns of main wire and eleven hundred turns of shunt wire. From these figures it follows that at full output the main exciting power is 4,900 ampere-turns, and the shunt exciting power 8,900 ampere-turns, or a total of 13,800 ampere-turns.

We also illustrate in Fig. 3 an American machine with internal poles. This is the Clarke dynamo, which has made some stir in America, though perhaps some of our readers will

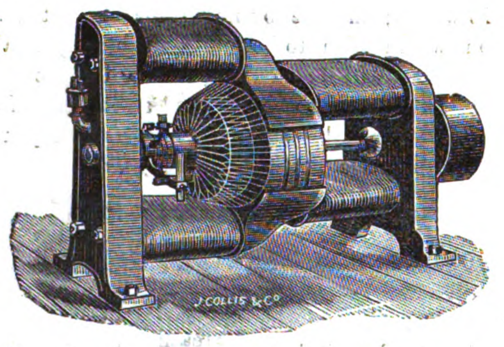

Fig. 3.

be inclined to think it rather an example of "how not to do it."

It would be interesting to know in this case what method has been adopted for holding the armature wire, there being no information at present on this point.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

Chapter VII.—*Simple Tests with Indicators (continued).*

(*Continued from page 289.*)

75. *(b) Tests for Identity of Wires.*—The detector is a ready means of identifying wires which are run together from, say, one part of a building to another, no distinguishing mark having been attached to them, or which have become mixed in passing together through walls or flooring. Gutta percha covered wires for telegraph work are manufactured with one or more ridges of insulating material running along their entire length, in which case any particular wire can be identified at any point by feeling its surface. Wires insulated with this distinguishing mark are in use at some cable stations, and serve to connect the cables from the beach at low-water mark to the cable house or thence to the town office. They are drawn through iron pipes laid underground, the latter being kept filled with water to preserve the insulation. In this case any wire can easily be identified by the number of ridges on its exterior.

For electric bell work the outside cotton coverings of wires leading from the different rooms to the annunciator are some-

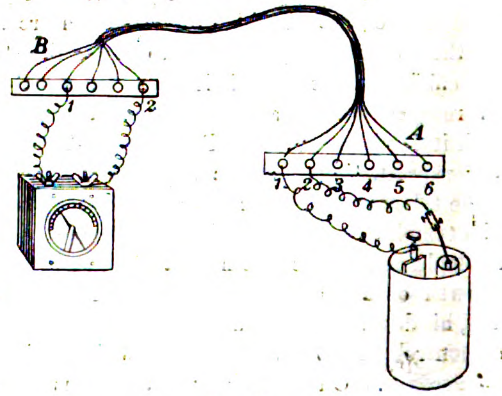

Fig. 35.

times differently coloured, so that anywhere throughout their length they can be identified.

Suppose, now, that it is required to identify six wires laid from a battery room to an office. We should start by numbering the wires at one end A (Fig. 35), and then connect, say,

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the copper pole of a cell to No. 1, and the zinc pole to No. 2. Now, on going to the other end B and trying the wires successively on the detector, the pair of wires that cause a deflection are, of course, Nos. 1 and 2; but this alone does not show which is which. This is determined by the *direction* of the deflection. Suppose that by a previous trial it had been ascertained that when a cell was connected up directly to the detector the needle was deflected *towards* the terminal at which the current *entered* the instrument (*see* Chap VI., para. 56) we should know that the needle would point towards the terminal connected to No. 1. We have therefore identified Nos. 1 and 2, and they should be so marked at once. No. 1 may now be kept attached to one pole of the cell in the battery room, and one terminal of the detector in the office, while all the other wires are identified in turn. Thus, No. 3 being connected to the other pole of the cell, the wire which when touched by the other terminal of the detector gives a deflection is No. 3, and so on, till the last but one is done, and then all are known.

76. (*c*) ***Test for Insulation.***—A sensitive indicator of the horizontal type described in para. 72 and illustrated in

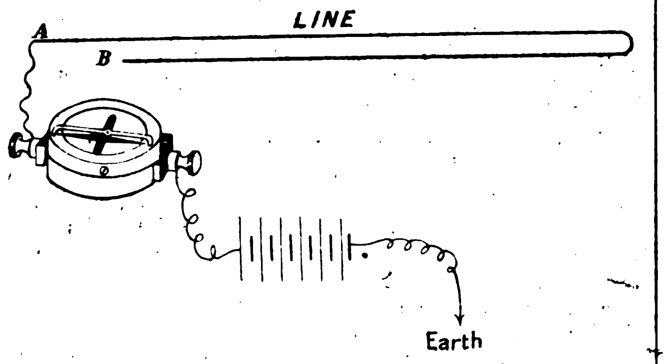

FIG. 36.

Fig. 31 may be used for testing the insulation of a circuit where it is not so important to know the exact resistance of the insulation when perfect as to keep up a daily inspection that it does not fall below a certain amount. An indicator of

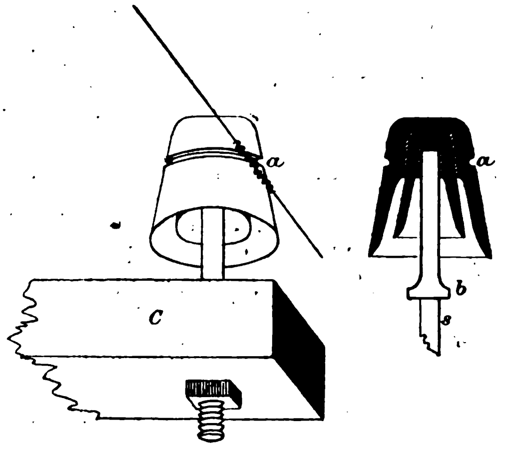

FIG. 37.

this type will give 10deg. deflection with one Leclanché cell and 150,000 ohms in the *external* circuit, the coil of the instrument itself measuring 1,000 ohms. With these high resistances, that of the cell would be practically negligible. Up to such a small angle as 10deg. the deflections may be taken as proportional to the currents, and therefore inversely proportional to the total resistances of the circuit. That is, 1deg. deflection would represent (150,000 + 1,000) 10 = 1,510,000 ohms, or 1·51 megohms total resistance, which, deducting the resistance of the instrument, would be 1·509 megohms in the external circuit.

By increasing the number of cells the instrument could be made to read up to a much higher resistance.

The connections would be made as in Fig. 36, the battery being connected through the instrument to one end of the main wire, whose insulation resistance is to be found, the other end, B, of the wire not touching anything, or as it is termed left "free." The other pole of the battery must be connected to earth, this connection being easily made on to a water pipe which runs underground. If this connection is made permanently it must not be to a *lead* gas pipe, or indeed to any *lead* pipe, a plate of galvanised iron sunk in the ground being the best. Now, let us suppose that the wire A B is an aerial one, and is run on poles either from roof to roof, as is the case in London with the electric lighting and telephone wires, or on poles along the streets, as with arc lighting, telephone, and telegraph wires in the provinces. At every post the line wire is bound by wire to a porcelain insulator at the groove marked *a* in Figs. 37 and 38, which ex-

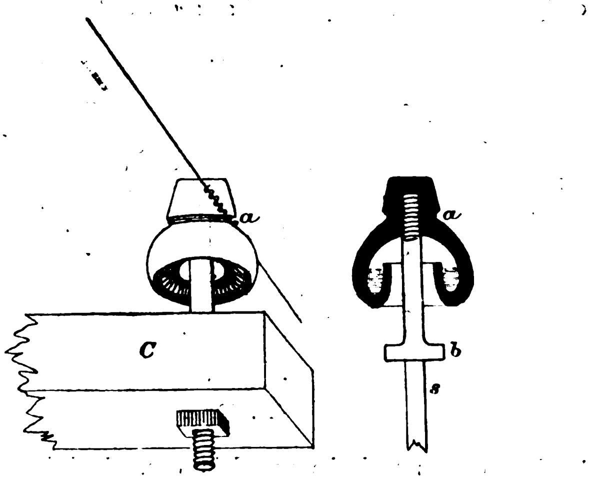

FIG. 38.

hibit two most approved forms largely in use now. Mr. Latimer Clark's double-cup form, shown in Fig. 37, presents a large insulating surface between the wire at *a* and the iron stalk S, for any leakage of current from the wire down the post to earth must occur over the two outer and two inner

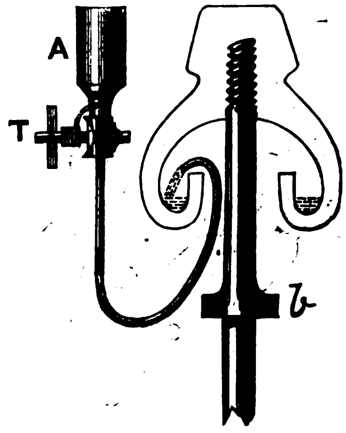

FIG. 39

surfaces of the cups before the stalk is reached. Messrs. Johnson and Phillips's fluid insulator is shown in Fig. 38, in section, and as attached to the cross arm, C, of a post. It will be seen that the lip of the insulator is turned up at the lower end, forming a well which is nearly filled with insulating oil, any leakage of current, therefore, having to traverse the outside and inside surfaces of the porcelain cup and over the surface of the fluid. The well of this insulator is filled with a measured quantity of oil by the siphon shown in Fig. 39, which is manipulated by first filling the siphon tube with oil, then closing the tap T and filling the reservoir A. This reservoir then contains exactly

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the proper quantity of oil, which is delivered into the well of the insulator when held as shown in the figure, and the tap T opened. The siphon tube does not, of course, require refilling, and the next is proceeded with by closing T and filling A as before. This form of insulator offers a high insulation resistance to leakage, and is specially suitable for electric lighting circuits where the high E.M.F. in use tends to open up the weak points in the insulation. These insulators are fixed up by passing the stalk through a hole bored in the cross-arm C of the post, as far as the projection *b*, the nuts then being screwed on underneath, fixing them firmly in position. To avoid the strain on the insulator when the wire to and from it forms an angle, and to overcome the friction between insulator and wire when the latter is heavy or the span between two posts is long, the *shackle* insulator is employed. A double shackle insulator, supporting an electric light insulated main wire, and bolted to an iron pole, is shown in Fig. 40. The wire itself is always continuous at the shackle, and in the case of lighting wires is firmly bound at *a a* with tarred twine after

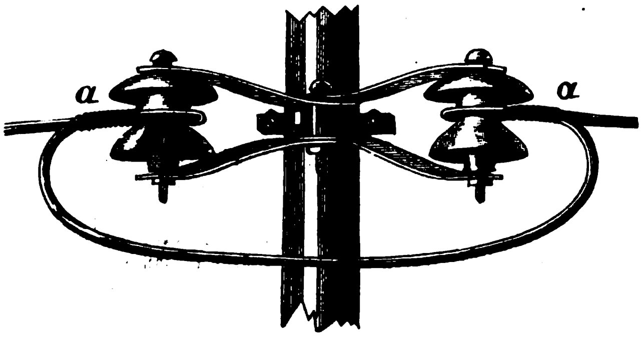

FIG. 40.

bending once round the porcelain cup. Lighting wires in London are run in this way, shackles being fixed to every pole to bear the strain of the heavy wire, and the iron poles themselves being planted on roofs of buildings, and kept in their position by wire rope stays. In addition to shackling, the strain of heavy wires is borne by a

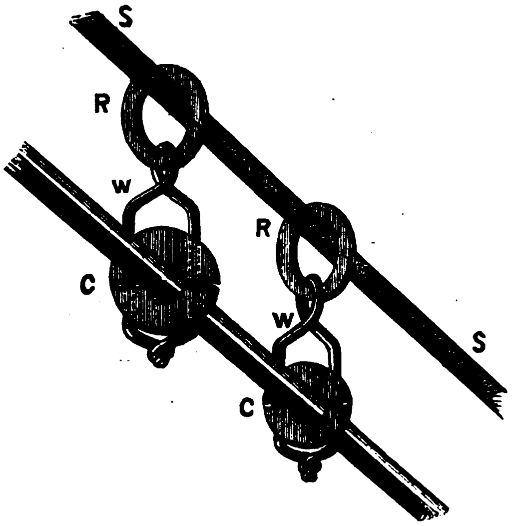

FIG. 41.

steel wire rope suspender, S S (Fig. 41), which illustrates one method of attachment. A vulcanite chair, C, carries the electric light wire, and this is suspended from the stranded steel wire by means of a galvanised iron wire loop, W, passed through the vulcanite chair, engaging in a split steel ring, R, which is threaded on the steel wire. The "shackling off" of a telegraph or telephone wire is somewhat different. About 2ft. of line wire is bound to each porcelain cup first, the line wire is then soldered to one of these ends, and brought round to the other end and soldered and carried on, slack being left between the two joints.

The insulation resistance of each porcelain insulator is tested under rigorous conditions after manufacture, being allowed to soak in water for forty-eight hours previous to testing, the resistance then averaging from 500,000 to four million megohms each (Prof. Ayrton in "Practical Electricity"), or say, on an average, one million megohms per insulator. When put up on a line and subjected to rain and dust the insulation resistance is, of course, reduced. In fine dry weather an insulation resistance up to 14 megohms per mile is obtained, but in wet weather it may fall to about $\frac{1}{50}$th of this; in any case it should not fall below 200,000 ohms per mile of line for telegraph and telephone work. In electric lighting by arc lamps in series with *direct* currents, or by incandescent lamps with *alternating* currents, and *transformers* in series, if the wires are run overhead in the above manner the insulation falls to a lower figure when *working*, owing to the high E.M.F. worked with, which tends to open up weak places in the insulating supports. For all lighting circuits, however, the wire is itself insulated and then wrapped round with a serving of tape. An arc light circuit will offer from one to two hundred thousand ohms insulation resistance per mile. Taking a line offering 200,000 ohms per mile, each resistance to leakage of 200,000 ohms is in *multiple arc* or *parallel circuit* with the others. Two miles would therefore measure 100,000 ohms, ten miles 20,000, and so on, and, the resistance being uniform, the rule is, divide the resistance per mile by the number of miles to obtain the total insulation resistance of the line.

It will be seen, therefore, that if even such a short length as one mile of overhead wire is taken, an insulation test with a delicate horizontal indicator as described above, would readily show whether the insulation was up to or below its required value; but with a longer line, the insulation resistance being reduced, the instrument would more sensitively detect changes. The writer has seen satisfactory tests taken this way with a similar instrument on an arc lighting circuit, the more delicate instruments not being always available or practicable to use.

(To be continued.)

ELECTRO-CHEMICAL THERMO-DYNAMICS.

(Letter from Prof. Willard Gibbs to the Secretary of the Electrolysis Committee of the British Association.)

Newhaven, Nov. 21st, 1887.

Professor Oliver J. Lodge.

Dear Sir: As the letter which I wrote you some time since concerning the *rendement* of a perfect or reversible galvanic cell seems to have occasioned some discussion, I should like to express my views a little more fully.

It is easy to put the matter in the canonical form of a Carnot's cycle. Let a unit of electricity pass through the cell producing certain changes. We may suppose the cell brought back to its original condition by some reversible chemical process involving a certain expenditure (positive or negative) of work and heat, but involving no electrical current nor any permanent changes in other bodies except the supply of this work and heat.

Now the first law of thermo-dynamics requires that the algebraic sum of all the work and heat (measured in "equivalent" units) supplied by external bodies during the passage of the electricity through the cell, and the subsequent processes by which the cell is restored to its original condition, shall be zero.

And the second law requires that the algebraic sum of all the heat received from external bodies, divided each portion thereof by the absolute temperature at which it is received, shall be zero.

Let us write W for the work and Q for the heat supplied by external bodies during the passage of the electricity, and [W], [Q] for the work and heat supplied in the subsequent processes.

Then $$W + Q + [W] + [Q] = 0, \quad (1)$$

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and $$\frac{Q}{t'} + \int \frac{d[Q]}{t} = 0, \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where t under the integral sign denotes the temperature at which the element of heat $d[Q]$ is supplied, and t' the temperature of the cell, which we may suppose constant.

Now the work W includes that required to carry a unit of electricity from the cathode having the potential V″ to the anode having the potential V′. (These potentials are to be measured in masses of the same kind of metal attached to the electrodes.) When there is any change of volume, a part of the work will be done by the atmosphere or other body enclosing the cell. Let this part be denoted by $W\rho$. In some cases it may be necessary to add a term relating to gravity, but as such considerations are somewhat foreign to the essential nature of the problem which we are considering, we may set such cases aside. We have then

$$W = V' - V'' + W\rho \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Combining these equations we obtain

$$V'' - V' = W\rho + [W] + [Q] - t'\int \frac{d[Q]}{t} \quad . \quad . \quad (4)$$

It will be observed that this equation gives the electromotive force in terms of quantities which may be determined *without setting up the cell.*

Now $[W] + [Q]$ represents the increase of the intrinsic energy of the substances in the cell during the processes to which the brackets relate, and $\int \frac{d[Q]}{t}$ represents their increase of entropy during the same processes. The same expressions, therefore, with the contrary signs, will represent the increase of energy and entropy in the cell during the passage of the current. We may therefore write

$$V'' - V' = -\Delta\epsilon + t'\Delta\eta + W\rho \quad . \quad . \quad . \quad (5)$$

where $\Delta\epsilon$ and $\Delta\eta$ denote respectively the increase of energy and entropy in the cell during the passage of a unit of electricity. This equation is identical in meaning, and nearly so in form, with equation (694) of the paper cited in my former letter, except that the latter contains the term relating to gravity. See *Trans.* Connect. Acad. III. (1878), p. 509. The matter is thus reduced to a question of energy and entropy. Thus, if we knew the energy and entropy of oxygen and hydrogen at the temperature and pressure at which they are disengaged in an electrolytic cell, and also the energy and entropy of the acidulated water from which they are set free (the latter, in strictness, as functions of the degree of concentration of the acid), we could at once determine the electromotive force for a reversible cell. This would be a limit below which the electromotive force required in an actual cell could not fall, and above which the electromotive force of any such cell used to produce a current (as in a Grove's gas battery) could not reach.

Returning to equation (4), we may observe that if t under the integral sign has a constant value, say t'', the equation will reduce to

$$V'' - V' = \frac{t'' - t'}{t''}[Q] + [W] + W\rho \quad . \quad . \quad . \quad (6)$$

Such would be the case, if we should suppose that at the temperature t'' the chemical processes take place reversibly with evolution or absorption of heat, and that the heat required to bring the substances from the temperature of the cell to the temperature t'', and that obtained in bringing them back again to the temperature of the cell, may be neglected as counterbalancing each other. This is the point of view of my former letter. I do not know that it is necessary to discuss the question whether any such case has a real existence. It appears to me that in supposing such a case, we do not exceed the liberty usually allowed in theoretical discussions. But if this should appear doubtful, I would observe that the equation (6) must hold in all cases if we give a slightly different definition to t'', viz., if t'' be defined as a temperature determined so that

$$\frac{[Q]}{t''} = \int \frac{d[Q]}{t} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The temperature t'', thus defined, will have an important physical meaning. For by means of perfect thermo-dynamic engines we may change a supply of heat [Q] at the constant temperature t'' into a supply distributed among the various temperatures represented by t in the manner implied in the integral, or *vice versâ.* We may therefore, while vastly complicating the experimental operations involved, obtain a theoretical result which may be very simply stated and discussed. For we now see that after the passage of the current we may (theoretically) by reversible processes bring back the cell to its original state simply by the expenditure of the heat [Q] supplied at the temperature t'', with perhaps a certain amount of work represented by [W], and that the electromotive force of the cell is determined by these quantities in the manner indicated by equation (6), which may sometimes be further simplified by the vanishing of [W] and $W\rho$.

If the current causes a separation of radicles, which are afterwards united with evolution of heat, [Q] being in this case negative, t'' represents the highest temperature at which this heat can be obtained. I do not mean the highest at which any part of the heat can be obtained—that would be quite indefinite—but the highest at which the whole can be obtained. I should add that if the effect of the union of the radicles is obtained partly in work—[W], and partly in heat —[Q], we may vary the proportion of work and heat; and t'' will then vary directly as [Q]. But if the effect is obtained entirely in heat, t'' will have a perfectly definite value.

It is easy to show that these results are in complete accordance with Helmholtz's differential equation. We have only to differentiate the value which we have found for the electromotive force. For this purpose equation (5) is most suitable. It will be convenient to write E for the electromotive force V′ − V″, and for the differences $\Delta\epsilon$, $\Delta\eta$ to write the fuller forms $\epsilon'' - \epsilon'$, $\eta'' - \eta'$, where the single and double accents distinguish the values before and after the passage of the current. We may also set $p\,(v' - v'')$ for $W\rho$, where p is the pressure (supposed uniform) to which the cell is subjected, and $v'' - v'$ is the increase of volume due to the passage of the current. If we also omit the accent on the t, which is no longer required, the equation will read

$$E = \epsilon'' - \epsilon' - t\,(\eta'' - \eta') + p\,(v'' - v') \quad . \quad . \quad . \quad (8)$$

If we suppose the temperature to vary, the pressure remaining constant, we have

$$dE = d\epsilon'' - d\epsilon' - t\,d\eta'' + t\,d\eta' - (\eta'' - \eta')\,dt + p\,dv'' - p\,dv' \quad (9)$$

Now, the increase of energy $d\epsilon'$ is equal to the heat required to increase the temperature of the cell by dt diminished by the work done by the cell in expanding. Since $d\eta'$ is the heat imparted divided by the temperature, the heat imparted is $t\,d\eta'$, and the work is obviously $p\,dv'$. Hence

$$d\epsilon' = t\,d\eta' - p\,dv',$$

and in like manner

$$d\epsilon'' = t\,d\eta'' - p\,dv''.$$

If we substitute these values, the equation becomes

$$dE = (\eta' - \eta'')\,dt \quad . \quad . \quad . \quad . \quad . \quad (10)$$

We have already seen that $\eta'' - \eta'$ represents the integral $\int \frac{d[Q]}{t}$ of equations (2) and (4), which by equation (2) is equal to the reversible heat evolved, − Q, divided by the temperature of the cell, which we now call t. Substitution of this value gives

$$\frac{dE}{dt} = \frac{Q}{t}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

which is Helmholtz's equation.

These results of the second law of thermo-dynamics are of course not to be applied to any real cells, except so far as they approach the condition of reversible action. They give, however, in many cases limits on one side of which the actual values must lie. Thus, if we set $\leqq$ for = in equations (2), (4), (5), (6), and $\geqq$ for = in (8), the formula will there hold true without the limitation of reversibility. But we cannot get anything by differentiating an inequality, and it does not appear *a priori* which side of (10) is the greater when the

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condition of reversibility is not satisfied. The term $\frac{Q}{t}$ in (11) is certainly not greater than $\eta' - \eta''$, for which it was substituted. But this does not determine which side of (11) is the greater in case of irreversibility. It is the same with Helmholtz's method of proof, which is quite different from that here given, but indicates nothing except so far as the condition of reversibility is fulfilled. (See *Sitzungsberichte, Berl. Acad.*, 1882, pp. 24, 25.)

I fear that it is a poor requital for the kind wish which you expressed at Manchester, that I were present to explain and support my position, for me to impose so long a letter upon you. Trusting, however, in your forbearance, I remain yours faithfully.—J. WILLARD GIBBS.

ON THE EFFECT OF LIGHT ON THE ELECTRIC DISCHARGE.*

BY E. WIEDEMANN AND H. EBERT.

Prof. H. Hertz, in a recent paper† on the effect of the ultra-violet rays on the electrical discharge, describes a series of investigations, showing that light rays have a certain influence on the passage of the electrical spark. This he found to occur exclusively in the case of the extreme ultra-violet rays. It was not determined whether this effect was caused directly by the action of the light, or was due to some other action, which was itself caused by the light rays. To gain a further insight into the matter, we first repeated the experiments of Dr. Hertz with perfect success, and then extended them further, with the following results. The source of light was always an arc lamp, but magnesium was used in a few of the earlier experiments.

1. The phenomenon occurs with the greatest regularity, not only when an induction coil is used, but also with a Holtz machine. In this case the spark under observation was arranged as a shunt on a spark micrometer, and the effect of light falling on the spark region was to lower the potential required to produce it.

2. In order to study the effect of the light rays during the passage of the electricity through the (passive) spark region, one pole of the machine was joined to earth, while the circuit from the other pole was first through the spark region, and thence either through an ordinary Geissler's tube, or through a rubber-cased telephone to earth. The effect of light falling on the spark was to change not only the note, but the whole character of the sound heard in the telephone. In the Geissler's tube the discharge, which was intermittent when no light fell on the spark, became steady and continuous. This was also very noticeable in the spark itself. All this, however, *only* took place when the negative electricity passes through the spark region. Where the positive passes, no difference was noticeable whether the spark region was illuminated or not. Care should be taken to avoid reflections of the light from the bright knobs and metal work, as they might interfere with the true phenomena. Inductive effects from the electricity accumulated on the knobs must also be prevented. If these precautions are taken, then if, with an illuminated spark (under atmospheric pressure), a certain note is heard in the telephone, it will be found that, when *no* light falls on the spark region, a buzzing sound will be heard, through which may be detected a very much deeper note. This, however, is only when joined up with the *negative* pole. With the positive there is *no* difference. The difference in the spark itself is also very noticeable. Without illumination, the path of the spark is irregular, and constantly changing in form and position, and owing to the persistence of vision, there appear to be several sparks at once. The moment the first ray of light falls on the spot at which the negative electricity enters the spark region all these paths close up into a single one along which the current flows perfectly steadily and evenly, and without the noise which accompanied the discharge when unilluminated. At both balls the discharge is perpendicular to the surface.

3. The intensity of the action of light on the −E depends very considerably on the pressure of the gas in which the discharge takes place. It reaches a maximum at a certain pressure and for a certain distance apart of the balls, and rapidly falls off if this pressure be either increased or diminished.

4. The source of light used is of great importance. The phenomenon shows itself best with light from the hottest part of the electric arc. The beam must strike accurately on the spot where the spark leaves the negative ball; the other ball should be shaded for the reasons already mentioned.

5. The phenomenon takes place in dry or damp air, in dry or damp hydrogen, and in carbon dioxide; in the last it is especially noticeable. The pressure at which the maximum effect is obtained varies with different gases; it has apparently a very close connection with the development of the cathode ray.

6. The phenomenon is not entirely dependent on the ultra-violet rays. This is best observed in an atmosphere of carbon dioxide, either dry or moist. Here rays which distinctly belong to the visible part of the spectrum have an undoubted effect. With the ultra-violet already cut off by a glass plate held in front of the light, a most distinct difference was observed if the more refrangible *visible* rays were cut off by further interposing a plate of red or green glass. Blue glass allowed a considerable proportion of the active rays to pass. That the effects were not caused by heat rays was proved by the fact that the interposition of a plate of alum, or a glass cell containing a solution of alum, did not interfere with the effect. It is as well to remember that the light at the cathode in carbon dioxide is of another colour to that in hydrogen.

The phenomenon occurs also in air when the ultra-violet rays are cut off, though not in such a marked degree.

7. From our experiments, and especially bearing in mind that it is only the negative electricity which is affected by light, we have come to the conclusion that there is a very close connection between the phenomenon and the production of the ray from the cathode (Entwickelung der Kathodenstrahlen.) Through the action of the light falling on the electrode the conditions of the production of the synchronously vibrating rays from the cathode is facilitated. Since the wave lengths of these rays are different in different gases, it follows that there must be for each gas a portion of the spectrum of various wave lengths which has more effect than the rest. The production of the cathode ray depends, further, on the pressure, but differently in each gas; consequently, the magnitude of the effect of light should depend on the pressure. It is, in fact, a sort of resonance phenomenon, and is in some degree comparable to explosion of substances which can only be brought about by the prior explosion of certain other substances. The cathode rays clear the way, as it were, for the discharge which follows.

* A Paper read before the Phys. Med. Soc. of Erlangen.
† *Wied. Ann.*, p. 983, 1887.

REVIEWS.

The Journal of the Society of Telegraph-Engineers and Electricians.

The sixty-eighth number of the *Journal* of this society is just issued, and contains the paper on "Deep Sea Sounding," by Mr. E. Stallibrass, the paper of Dr. Fleming, and that of Profs. Ayrton and Perry on "New Types of Voltmeter," together with the discussions which followed. There is also an original and important communication from Mr. A. E. Kennelly "On the Superiority of the 'Earth-Overlap' Method in Localising Small Faults in Submarine Cables when no Loop is Available." The abstracts from foreign periodicals are a well-chosen selection, and complete a number of unusual interest.

The sixty-ninth number of the *Journal* has followed closely upon its predecessor. This issue is made up of the report of the discussions on the papers on voltmeters, by Dr. Fleming and Profs. Ayrton and Perry; the proceedings of the sixteenth annual general meeting of the society, which took place on December 8th, 1887; and the paper by Mr. A. C. Cockburn, on "Safety Fuses for Electric Light Circuits, and on the

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Behaviour of the various Metals usually Employed in their Construction." This paper is fully illustrated, and contains the record of a valuable series of experiments, which were evidently carried out with considerable skill and care.

Transactions of the American Institute of Electrical Engineers.

With the December issue of the *Transactions* of the American Institute of Electrical Engineers the Institute commences the publication of an index of current electrical literature. The present instalment dates from October last, and contains references to more than 300 distinct articles, cited from about 50 journals, mostly of American origin. Subsequent issues will, we are informed, comprise the leading electrical publications in foreign languages. We have quite recently noticed the first issue of a German periodical, to appear quarterly, devoted to the same purpose, and publications of a somewhat similar character have long been issued in the French language, but nothing of the kind has hitherto appeared in English, and the Institute will deserve the thanks of every English student of electrical literature.

The present issue of the *Transactions* appeals exclusively to the Submarine Cable interest; it contains a paper on "Recent Improvements in Apparatus for Ocean Cabling," by Mr. Charles Cuttriss, one on "The Siphon Recorder and Ocean Telephony," by Mr. J. D. Lockwood, together with the discussion thereon. These papers are each of considerable interest.

THE PATTEN ELECTRIC MOTOR.*

We illustrate herewith an electric motor of novel construction invented by Lieut. F. Jarvis Patten, U. S. Army. Its novel features consist mainly in a new system of armature winding, commutators and connections, as well as some mechanical details worthy of notice. In the accompanying engravings, Fig. 1 is an elevation of the motor.

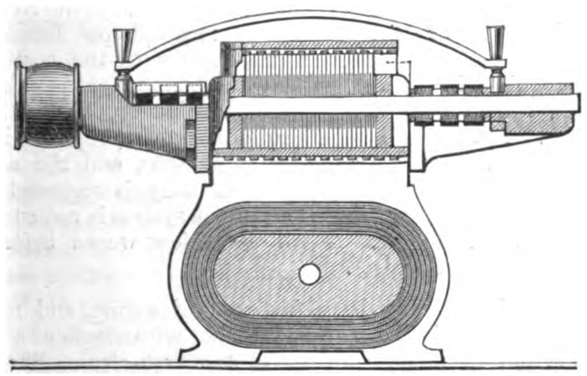

FIG. 1.

A noticeable feature of the machine is an exceedingly short magnetic circuit and a slightly unsymmetrical field, the purpose of which will be explained later. The motor has a comparatively large proportion of iron, a single magnet core and coil forming the yoke of a very short and stout electro-magnet, thus bringing the centre of gravity of the entire machine to the lowest possible point. To the core there is bolted by a single transverse bolt the two curved pole-pieces of cast iron, which are so shaped as to reduce the magnetic lines of force to their shortest length, while the armature fits so closely that there is but $\frac{1}{32}$nd of an inch of air space in the magnetic circuit.

Secured to the spindle is a three-coil armature of peculiar construction. The coils are wound longitudinally around three poles, radiating at angles of 120 degrees from the spindle. The armature may therefore be regarded as a drum armature with three coils and a minimum amount of inactive wire, the ends being shortened in the proportion that the length of a chord of 120 degrees or less is to that of a diameter of the same circle. These three coils of the armature are all continually in circuit in parallel arc, so that the armature consists of a three-coil multiple arc winding, thus reducing materially the armature resistance, as by the peculiar arrangement of the field described none of the coils of the armature are at any time cut out of circuit.

* From the *Electrical World*.

This system of construction admits further of a non-sparking commutator for all positions of the brushes, and is the result of the peculiar commutator connections rendered necessary. These are shown in Fig. 2.

As will be seen, there are practically two commutators, one revolving under the positive and the other under the negative brush, and the two brushes are placed upon the same side of the spindle and at opposite ends of the armature. This arrangement, it will be noticed, leaves the entire commutator exposed, so that it can be easily cleaned while the machine is running. In Fig. 2, the vertical lines E E represent a vertical diameture of the armature spindle, and each segment of the commutator is shown in its proper relative position thereto. An examination of the diagram of connections will show that each of the three coils is constantly in circuit, and is entirely independent of the other two. The action of a single coil during one revolution will therefore describe that of all. Thus, in Fig. 2, the coil A is shown with its terminals connected to two partial commutators, one revolving under the positive, and the other under the negative brush. The coil is secured by one terminal to the segment a^1+, and after traversing the armature has its other end secured to the segment a^1-, which revolves under the negative brush, and occupies exactly the same angular position on the spindle as the first segment. This last segment, however, is also connected by a free conductor r^1r^1 back to the second segment $a^2+$of the first half commutator; and the segment $a^2-$of the second half is likewise connected by the free conductor r^2r^2 back to the short segment $a^1+$of the first half.

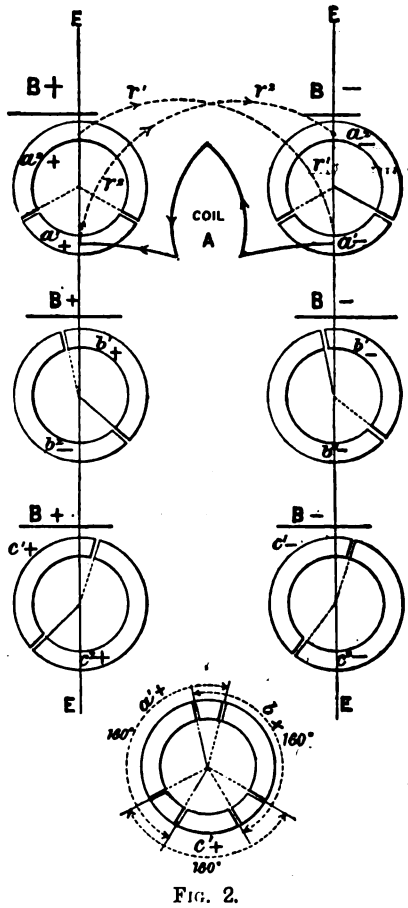

FIG. 2.

The other coils of the armature are similarly connected to their corresponding commutator segments, the only difference being that the corresponding segments for the different coils are placed in rotation around the spindle so that their middle lines make with each other angles of just 120 degrees.

If now the current be regarded as flowing direct from the positive to the negative brush, and the result during a single complete revolution of the coil A be traced, it will be seen that while the short segments $a^1+$and $a^1-$are under their respective brushes the current will flow direct in the coil A from the positive to the negative brush. When, however, the short segments pass out of action the current will flow from the positive brush B+, through the long segment a^2+, the free conductor r^1, over to the short segment a^1- (no longer under the negative brush), then back through coil A in a reverse direction to the short segment a^1+(no longer in contact with the positive brush), and thence through the free conductor r^2r^2 to the long segment a^2-, and out through the negative brush as before.

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It is therefore plain that the current flows direct in any coil while the short segments are under the brushes, and in a reverse direction whenever the long segments are in contact with the brushes; and this change takes place alike for each of the armature coils in rotation.

The relative amount of direct and reverse current taken in a revolution by each coil will depend upon the relative amount of the spindle circumference covered by the long and short segments, and this must necessarily depend upon the amount of distortion or unsymmetrical arrangement of the field, which, for well-known reasons, must have comparatively narrow limits. This distortion of the field amounts practically to changing the diameter of commutation from a right line (diameter) to a broken line, consisting of two radii meeting in the centre of the spindle, an effect involving, it is claimed, no disadvantages under the conditions as secured and provided for, viz., that both brushes are on the same side of the spindle.

If, now, the further condition be borne in mind that the coils must of necessity radiate at equal angles of 120deg. from the spindle, and we give to the field-poles a relative position, as shown, such that the points on the armature circumference where the current must change direction are at the extremity of radii that are inclined at some angle between 140 and 160deg., it will result in giving to the armature a continuous unbroken circuit, and as the three coils are always in parallel arc, there can be no short circuiting of the coils due to the brush bearing upon two different segments simultaneously.

This effect is shown by the lower diagram in Fig. 2, in which the short segments are shown as covering arcs of 160deg. each of the spindle circumference. Any two successive ones must therefore overlap by an angle of 20deg., from which it results that there is no point during a complete revolution at which the armature circuit is broken. For, as the current changes from any one coil at any point, there are two others in contact with the same brushes that form a continuous circuit. The resultant effect amounts practically to making a set of commutator segments that cover $3 \times 160 = 480$ degrees, each single part overlapping the other by an amount equal to $\frac{1}{3}(160-120) = 20$ degrees.

Another result of this peculiar form of armature construction is the complete elimination of a dead centre, there being at all points of a single revolution a continuous rotary torque, which may be expressed as the resultant effect of three separate tangential efforts which can never be so placed as to neutralise each other.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Jan.* 21*st*, 1888.

It looks as though murderers in the State of New York will hereafter be executed by electricity. In 1886 a Special Commission was appointed by the Legislature to report on the most humane and practical methods known to modern science of carrying out death sentences in capital cases. After an exhaustive inquiry the commissioners have reported in favour of electricity. Their report is quite voluminous. It is in many ways a valuable document, and is probably the most complete treatise on the subject of capital punishment now extant or of any utility. The commissioners have inquired into and enumerated specifically the various modes of punishment that have been in vogue in times past, or are now practised. The various objections to the most likely methods are considered, and the views and opinions are given of a large number of judges and judicial officers. To the electrician the most interesting part is that which deals with electricity, which the commissioners speak of as "the most potent agent for destroying human life;" and among the authorities cited on the subject are Prof. Helmholtz, Prof. Tyndall, Mr. Edison, and Prof. Elihu Thomson, the last two of whom contribute their views, which are printed in the report. The commissioners recommend that the current shall be administered to the criminal by means of a chair, with a head-rest and foot rest, and that the current should be obtained from any local electric light plant, or, if desirable, from an independent machine in the prison. It may be noted that Prof. Elihu Thomson objects to the use of a chair, and recommends, as the most certain way to produce death, the passage of the current down the spinal chord from the crown of the head by the application of wet surfaces or sponges. As an illustration of the manner in which the electric system would work, the commissioners instance the wholesale destruction of dogs carried on at Buffalo last year at the dog pound in that city. In this case, as you may perhaps have noted at the time, each captured cur was placed in a pine box, lined with zinc, and partly filled with water, and his nose was fitted into an iron or copper muzzle. Current was then turned on and the death of each dog was instantaneous. In order to deprive the criminal of any of the cheap and hideous glory that now attends an execution, the commissioners propose that electrical executions shall take place in private, and that even the day of death be made uncertain. The Bill incorporating the recommendations of the commissioners will, if it becomes law, take effect on January 1st, 1889; and as the public sentiment is generally in favour of the new system, it is likely that, in New York State at least, electricity will be made the means of inflicting the most dreadful sentence of the law. I believe that some action of the same kind has been contemplated in Pennsylvania, where a chair for electrical executions has been submitted to the notice of the Legislature. It seems not improbable that New York will take the initiative in this matter.

Another week has come and gone, and still we have no decision from the United States Supreme Court in the Bell Telephone case; in fact, it is now reported that the Court may take a long adjournment—until March—before presenting its verdict. With so much at stake it need hardly be wondered at that the anxiety felt in some quarters is very keen. The richness of the prize becomes more tempting every year. In 1887 the parent company earned 22½ per cent. on its £1,960,000 capital; in 1886 the earnings were about 20 per cent., and in 1885 they were 18 per cent.

You in England are tolerably familiar with petitions that bear miles of signatures, and we now have something of the same kind here in the monster memorial to be presented to Congress by the Knights of Labour in favour of Government telegraphs. This movement was started some little time ago, and was then mentioned by you. The petitions are now being returned to the Knights' head-quarters in Philadelphia. The first batch was received on January 3, when two trips of a mail delivery waggon to the post office were required in the morning and another at night to clear the boxes; while a large number of bulkier packages came in by express. Mr. Powerby, the head of the order, rejoices in the possession of about half a-million autographs, and the energy that has been shown throughout the body is regarded as a sign that the feeling against the present system is not confined merely to the leaders. It will be a few weeks before the petition reaches Congress.

Chicago has already been favoured of nature and man in many ways, and is about to add to her advantages as a commercial and manufacturing city of the first class. She is to have her own supplies of oil and natural gas, and will not have to go far for either of them. It was proposed to pipe gas for the Indiana wells 150 miles off, but gas has now been struck not only in East Chicago, but in the heart of the city; and the supply of gas and oil at East Chicago promises to be "inexhaustible." The ingenious proposition is made to run the oil and gas thence into the city in one and the same steel pipe, the gas furnishing the pressure. Arrived at Chicago, each would run into its own receiver to be stored or used. The interest in this matter to electrical engineers is that a stimulus to electric lighting is expected if the discovery proves as valuable as it now promises to be. With natural gas at 10 or 15 cents per 1,000ft. it would be easy to manufacture current very cheaply for light and power, and that is the view taken in electrical circles in Chicago.

The decision against the French Cable Company by the Tribunal of Commerce cannot be said to have been unexpected here, one ground of belief being that great care was taken at the time the arrangement was made to have it as valid and binding as possible. It is rumoured, by the way, that higher cable rates are near at hand, and there has been some little discussion as to the effect of an outbreak of war in Europe on

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the cable situation. Such a war would add tremendously to the volume of business, and might lead the companies to a better tariff simply to keep business within bounds. I do not think the staffs of the various companies view low tariffs with the slightest degree of approval.

CORRESPONDENCE.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS AND THE PARIS EXHIBITION OF 1889.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am instructed by the President and Council of the Society of Telegraph-Engineers and Electricians to request the favour of your giving as early an insertion as possible to the following notice:—

"In view of the interests of English Electrical Exhibitors, the Society of Telegraph-Engineers and Electricians have appointed a committee to endeavour to ascertain their wishes and to make arrangements on their account with the French authorities. The Director-General of the International Exhibition having requested the society to take part in the matter on behalf of the official administration, it is proposed shortly to address a circular to the principal firms interested in electric lighting and kindred pursuits, and to convene a meeting of gentlemen who are likely to take part as exhibitors in the forthcoming display.

"It is of extreme importance to British industries that they should be well represented on the occasion referred to, as without it there is danger of Continental opinion assuming that England has fallen back in the race for success in the alliance between science and commerce."—Yours, &c.,

F. H. WEBB, Secretary.

Society Telegraph-Engineers and Electricians,
4, The Sanctuary, Westminster.

OVERHEAD WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Caws invites attention to the fact that no writer has yet succeeded in sustaining one objection to his spring shackles. He has forgotten my objection that they are utterly useless against the only stresses that break telegraph wires.—Yours, &c.,

W. H. PREECE.

January 31, 1888.

INDIA RUBBER COMPENSATORS FOR OVERHEAD WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Caws, I would refer him to my remarks in *The Electrician* of the 6th inst., that "the table could be amended, as found by experiment to be of the greatest advantage, by altering either the quality or the thickness of the india rubber."

If (as Mr. Caws states) I should have to multiply by 16 the weight of my india rubber, my compensator would in that case have almost the same disadvantages as the springs which I abandoned as useless for the purpose. I agree with Mr. Caws that I should not improve the insulation by cutting the wire at each post, and do not propose to do so; in fact, that is one of the great features of my plan. I do not remove the old insulator from the line, but withdraw the bolts and substitute my compensator for the ordinary two strips of the shackle. As far as the insulation is concerned, it would remain exactly as it is at present.

To conclude, I should much like to know how Mr. Caws proposes to protect his springs from the weather, and especially the gases in the air over large cities. Does not the process of galvanising eat through the surface, thereby making the spring perfectly useless unless applied considerably over the size and strength theoretically specified? I cannot say I have had seventeen years of experience and study, but as an engine fitter at Messrs. Maudslay, Sons and Field it must be admitted at least I am practical, and my opinion is that there is nothing at present so well suited for compensating overhead wires as india rubber.—Yours, &c.,

R. S. BOZON.

January 30th, 1888.

THERMO-ELECTRICITY.

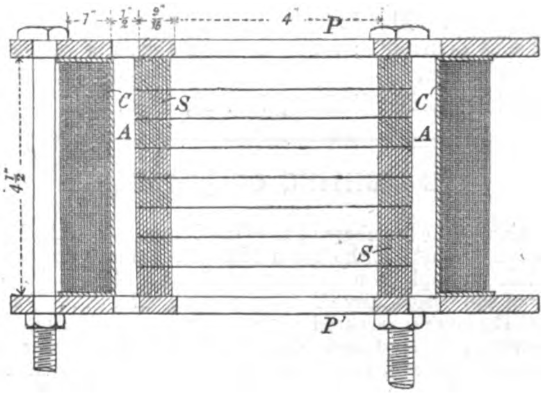
TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your account of Mr. Acheson's experiments in this week's *Electrician* are interesting to me, as I trod the same or similar ground only a few months ago.

Some desultory experiments I was making with a spiral of iron wire gave results which recalled to my mind the discovery by MM. Hinghausen and Nerust announced in *The Electrician* last February; but the effects I observed were much stronger than that announcement would lead one to expect. I felt impatient to test the practical utility of the effect, and forthworth set about the construction of an apparatus for the purpose.

The view I took of MM. Hinghausen and Nerust's discovery was as follows:—As in ordinary magneto-electric induction we have three actions, each of which must be inclined to the plane of the other two, giving maximum effect when the direction of motion is perpendicular to the lines of force, and also to the path of the current, so the best conditions for this new effect are fulfilled when the thermal current, the lines of force and the path of the current are each at right angles to the others.

Now, if a conductor be traversed at right angles by lines of force and by a thermal current at right angles both to the conductor and the lines of force, any given length of it will develop a certain E.M.F. depending upon the strength of the field, the thermal current, and upon the nature of the conductor. Similarly, any other equivalent length of the conductor will develop this E.M.F., so that the aggregate E.M.F. will *cæteris paribus* be proportional to the length of the conductor, and the quantity will obviously be proportional to its sectional area.



Upon this principle I constructed a pile of iron spirals, S, made of iron tape $\frac{9}{16}$in. wide and $\frac{1}{16}$in. thick, connected in series, and containing a total length of 80ft. Wrought-iron plates, P P, $\frac{3}{8}$in. thick, formed the pole-pieces, and a circle of $\frac{1}{4}$in. holes were punched in each, opening into the annular space A, between the outside of the iron spirals and the copper exciting coil C. The side bolts held the whole together. The interior of the iron spirals could then be heated by means of a spirit lamp, a porcelain cell being fixed in the centre to compel the draft to move over the inner surfaces of the iron.

The exciting coil was connected to the screws of a good-sized bichromate cell. When the outside of the iron spirals became hissing hot, and a powerful cooling draft rose through the annular space, showing that a good thermal current was flowing at right angles to the conductor and to the lines of force, the effect from these 80ft. of $\frac{9}{16}$in. by $\frac{1}{16}$in. iron tape,

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whose terminals were connected with a reflecting galvanometer, was not quite, but *almost absolutely, nil.*

Care was taken to guard against ordinary thermo electric effects, and the strength of the field was tested roughly by connecting each spiral separately with the galvanometer through a resistance and observing the extent of the first swing at making or breaking the exciting circuit, and it was found that the 11lb. of copper wire used gave a pretty strong field. I remember doing this also when the iron coils were hot, when I should, according to Mr Acheson's observations, have observed an enhanced induction. Such was not the case.

I give this bit of experience for the benefit of any of your readers who may be tempted to exercise their ingenuity upon the discovery of MM. Hinghausen and Nerust.

I was taken aback at the result of my investigation, and returned to my original experiments tosee what was the matter, and found that in the first instance I had made a grave mistake by regarding a spiral of galvanised iron wire as iron wire, there being a remarkably strong variation in the thermo-electric strength of different parts of the wire, so that certain points in it were equivalent to ordinary junctions of dissimilar metals, and that insufficient provision against chemical effects in subsequent hastily conducted test experiments gave a series of remarkable fortuitous coincidences in the results, each corroborative apparently of the fundamental assumption which gave me a false impression of its importance.

But for MM. Hinghausen and Nerust I had been less precipitate.—Yours, &c., R. SNOWDON.

Stavely Ironworks, 27th Jan., 1888.

SAFETY FUSES WITH SPRINGS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your notice of a paper by Mr. Cockburn on safety fuses, one is mentioned as designed by Sir W. Thomson, consisting of springs, united by a button of fusible alloy, which fly apart when the alloy melts.

This, I believe, is the subject of a patent by him. I believe, however, I am correct in saying that a patent for exactly the same thing, and taken out by Mr. Boys and myself, is some years prior. I have no doubt that the inventions were entirely independent, and though I believe that neither Sir W. Thomson nor ourselves have ever caused them to be commercially manufactured, yet our experiments have shown that the matter is worth pursuing. The difficulty is to make them uniform when used for small currents; for large ones they are very satisfactory.—Yours, &c., H. CUNYNGHAME.

Hurlingham Lodge, Fulham, Jan. 27, 1888.

THE LIGHTING OF BRADFORD.

A meeting of the members of the Gas Committee of the Bradford Corporation was held at the Town Hall on Friday last to confer with Dr. J. S. Hopkinson in reference to the electric lighting of portions of the borough by the Corporation. Mr. J. N. Shoolbred, M.Inst.C.E., having prepared a scheme upon a basis suggested by the committee, it was thought desirable that an eminent authority on such matters should be called in with a view of some feasible scheme being adopted. Dr. Hopkinson, accompanied by the members of the committee, examined various sites for the necessary plant required in carrying out the suggested scheme, and concurred in the view of the committee that certain land belonging to the Corporation, in Bolton-road, was the most suitable. As to the area to be supplied with the electric light, it was thought desirable that an installation be laid down, on the site suggested, of sufficient power to supply the central portion of the town, lying in the vicinity of Kirkgate and Market-street, as already approved by the council, to be on the low-pressure continuous-current principle. As a result of the interview, it was ordered that a specification of the proposed works should be prepared by Mr. Shoolbred, to be submitted to Dr. Hopkinson; and this being approved, the works will be let by tender. The specification will be framed to give an opportunity to the council to secure the best electrical appliances possible, compatible with the cost being brought within the sum of £15,000 proposed to be expended by the Corporation as a first outlay; the works to be so arranged that, if deemed necessary, they may be extended in accordance with the wishes of the council.

SOCIETY OF TELEGRAPH-ENGINEERS.

At the ordinary weekly meeting of this society on Thursday evening, the discussion on Mr. A. C. Cockburn's paper on "Safety Fuses for Electric Light Circuits" was proceeded with.

The President (Mr. Graves) was in the chair, and there was a good attendance.

[Before giving our report of the discussion we may refer to the adjoining figures, which illustrate the type of fuse introduced by Mr. Cockburn. Fig. 1 shows the fuse of lead wire, with the pellet of lead attached to the

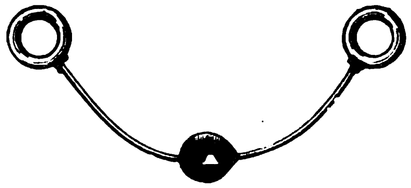

FIG. 1.

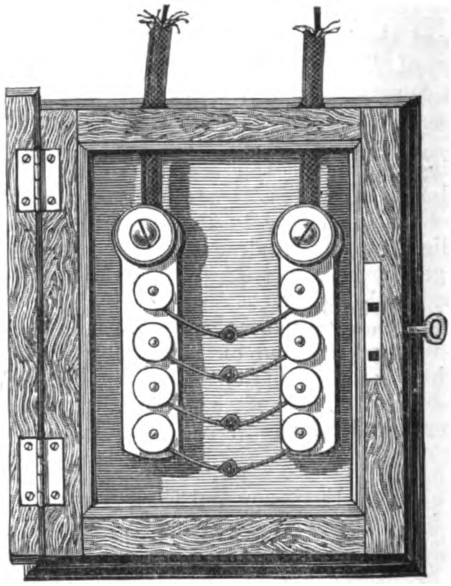

FIG. 2.

centre. Fig. 2 shows the compound fuse as employed for main leads carrying heavy currents.]

Prof. S. P. THOMPSON said he had been cognisant of the experiments of Mr. Cockburn during the whole time they had been going on. Referring to the fact that it required a larger current to produce the same result when the wire was short, Mr. Cockburn said one inch and a-quarter should be the length for the fuse, but he (Prof. Thompson) did not know whether he meant that as a dogmatic statement. If they had thin terminals an inch would give more than sufficient length. It was a question for experiment what was the best length under any given conditions. It was clear, however, they could not have very small terminals; they must have them large enough to be able to attach the fuse to them with comfort. It would not do to have microscopic screws. The conductivity of the material of which the terminals were made would have a great deal to do with the question. If copper was used there would be a certain cooling effect; if brass terminals were used it would be less, as brass was a worse conductor of heat than copper. He had never heard of any fuse before that could be relied on to melt with a current the strength of which was within any thing like three per cent. of the current it was supposed to go off at.

Mr. K. HEDGES wished to point out that Mr. Cockburn's novel application of fuse was not new. He used apparatus some years ago designed on the same plan. It appeared to him that Sir W. Thomson had really done everything that had been put forward in the paper. He would read his description of the fuses:—"The essential conditions fulfilled in the construction of these fuses are—(1) certainty and uniformity in action, (2) smallness in the percentage loss of energy in the fuse itself, (3) facility in replacing a fresh fuse. These objects are attained by making the fuses of two springy pieces of high conductivity copper, in which heat due to the current is generated, and uniting them by a soldering of fusible metal which melts at a very moderate temperature. The copper springs are made of such form and are so placed as to give complete severance of the circuit with instantaneous stoppage of the following arc when the melting of the fuse has taken place. The fuses are of two kinds—the spiral fuse, which is the form of fuse designed for currents of from ten amperes down to a half ampere, and what is called the Z fuse, on account of the similarity of its shape to the letter Z, is designed for any current of from six amperes upwards to hundreds or to thousands of amperes." Spiral fuse: In a spiral fuse two spirals of copper are used. The outer

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ends of these spirals are fixed to copper caps closing the ends of a containing tube of glass. The inner ends are soldered together with fusible metal. If the copper wire becomes overheated the fusible metal melts. The spirals then contract in opposite directions and the circuit is broken. The glass case of fuses of this class may be returned to the maker when the fuse has been melted in order to have the fuse restored. The Z fuse consists of straight pieces of copper wire with two extremities, soldered together by fusible metal and with the other ends bent into loops, which guide the fuse into position in the fuse-holder. The fuse-holder is a box lined with slate or mica, at the ends of which are two binding clamps so placed that the screwing up of the clamping screws puts a double bend into the otherwise straight fuse. In consequence of this bend the two parts of the fuse spring together as soon as the current exceeds the prescribed amount. The great point about Sir Wm. Thomson's fuses was the question of the loss of energy, and in a letter to him (Mr. Hedges) he had put it at a quarter of a watt for 12 amperes of current. The results of other experiments were much higher than that, probably because of the difficulty of making a good connection with the fusible wire and the terminal. His (Mr. Hedges) experiments showed about one watt per six amperes. As regards the accuracy of the foil, he thought it was a question of coating the foil to the right size and using it in the proper way. He could not see why fuses should not be made under certain circumstances to protect lamps. He thought this discussion should raise the very important question of the margin to be given to fuses. He quoted from the eleventh edition of the Phœnix rules, to show that the two constructions given did not agree. A rule said 50 per cent. should be allowed for cut-outs, and then further on, for double table cut-out, 25 per cent. The old rules of the Telegraph-Engineers said the fuse should be arranged so that no part of the system should obtain a temperature of 150deg. F. He did not understand what that meant. It must be a very fusible metal to go at 150deg.

Mr. Preece said this was a subject to which he had devoted a very great deal of attention, more from a scientific aspect than a practical one; although he was bound to confess he had had a considerable amount of experience in the defects as well as in the advantages of cut-outs. Mr. Cockburn's paper was, so far as he could remember, the first systematic effort to draw what had been rather in a state of chaos into something like a scientific position. Mr. Hedges had said there had been other workers in the field. They knew Mr. Edison was the inventor of cut-outs, but he was afraid that because he did not patent it he had not received sufficient credit for being the originator of this system. It had also been pursued by Mr. Hedges, and he did not hesitate to say that his form of fuse had been one of the most useful that had been in the market. He had used it for the past four years in his house, and he had derived considerable benefit from its proper behaviour at the right moment. Again, Sir Wm. Thomson had devoted a considerable amount of attention to the matter, and his fuse was certainly most efficient, and extremely pretty in its form. He was very much inclined to think that this question of cut-outs was very much overdone. They had cut-outs forced upon them in all directions. They must remember this, however perfect a cut-out may be, it also brought with it its own defects. One building that he had something to do with had so many cut-outs in it that he found on going into the matter that the cut-outs themselves had introduced no less than six thousand bad joints [laughter], so that they had not only these cures producing their faults, but also their dangers; and he should say that out of every ten failures of electric lighting that he had had to inquire into nine had been due to the failure of cut-outs [hear, hear]. The whole question had now been thoroughly and efficiently thrashed out. In 1884 he read a paper before the Royal Society on the heating effects of electric currents, and the origin of that paper was that they protected, and had done so for the last twenty years or more, all their submarine cables from the dangers of atmospheric electricity by supplying them with a cut-out. At the end of every cable there was a lightning protector in the form of plate and a vacuum tube, and in addition they also inserted a fine piece of platinum wire, which should fuse before the current could acquire sufficient strength to be a danger. It became a matter of great consequence to know what should be the proper size of this wire. There were currents induced by atmospheric electricity that exceeded very little the strongest that were used in actual work, and therefore it became desirable to have such a cut-out that should not fuse with the most powerful working current until that current was exceeded by some 50 per cent. He made a series of experiments, and it proved the law that had been originally published by Mr. Kempe, and developed by Prof. Forbes

$$C = d^{\frac{3}{2}} \times a.$$

His first experiments were devoted to proving the accuracy of that law, and while they did show that below a certain size when the wire was very fine the law was not verified, when they came to wires of 10 mils and beyond then the law was strictly and absolutely true (hear, hear.) Now, having shown that law to be true from platinum, it became desirable that they should know how far that law was true for all sizes and for all wires. During the past twelve months he had been engaged in determining the value of the constant a for all metals, and in his paper in 1884 he pointed out the error that might arise from the cooling effect of the mass of the terminals. He showed that when they used lengths of six inches they were outside that error, so that all his experiments were made with lengths of six inches. In a paper which he had lately sent to the Royal Society, but which had not yet been published, he had taken two cases—one where the length of the wire was only an inch and a-quarter—that being the minimum length for cut-outs, and in the other the lengths were six inches, and he took three fiducial points. He wanted, if he could, to determine a current that would raise a wire to a certain temperature. The rule of the Telegraph-Engineers implies that leads and mains should never be designed so that when the maximum current passes through them their temperature is raised to 150 deg. The point he took for observation was the point when the wire reached a sensation of warmth. He found that the sensation of warmth was extremely uncertain, and in order to avoid being dependent upon the very sensations that different observers found he used a thin flake of shellac, and when that wire acquired a temperature of 77deg. Centigrade that shellac melted. The second fiducial point was when the wire became red hot. The wire became just visibly red always at the same temperature. The third fiducial point was the fusing current. Taking these three points, he used copper, aluminium, platinum, German silver, platinoid, iron, tin, tin-lead alloy, and lead, and for all these materials there were various sizes, commencing at 10 mils and going up to 40. The measurements were given in inches and in centimetres, and the gauge of the wire was given, and for all these wires, and for all these results the constant a has been calculated. In these experiments a very curious thing came out, viz., that shellac acted as a kind of flux and prevented the oxidation of the metal, so that his shellac flake acted in almost the same way as Mr. Cockburn's little lead pellet, and the result was that it always went with 25 per cent. less current than when there was no shellac at all. Another interesting fact came out—viz., that these three fiducial points in the case of platinum were separated by temperature in the ratio, roughly, of 1, 2, 3, so that if they had a piece of platinum wire and a current of temperature which would melt shellac, twice that current would make it red hot, and three times that current would fuse it. The third series of experiments were made to determine what took place when they had a sudden short-circuit, throwing on to the leads a sudden current, and resulting in a sudden burst up of the cut-outs. It was very important to know how the different metals behaved themselves under different circumstances when a current of great strength was passing through them. He took tin, platinum, silver foil, silver wire, zinc foil, zinc wire, copper, &c., in fact, everything he could get hold of, and in the result he found that the best metal to meet such a case was platinum. It went off like wax; it did not burst from explosion, but went off gently. Tin was good in itself, but the other things scattered the molten particles about, and were really extremely dangerous to use. When they remembered the great variation in the gauge of wires and the different qualities that existed, it was not surprising that cut-outs varied from 5 to 10 per cent. from the figures attached to them. If they got within 10 per cent. they should be satisfied. His own impression was that they had got to 10 per cent. His great objection to cut-outs was the multiplication of bad joints. Every single screw was a loose joint, and sooner or later was certain to produce a fault. Mr. Preece strongly recommended the use of platinum for small cut outs as being cheap, never oxidising, and being capable of being screwed under a nut and remaining there for a long time in a perfect condition.

Prof. Ayrton confirmed the view of Mr. Preece with regard to the testing of the law stated by Mr Kempe and developed by Prof. Forbes.

Sir David Salomons said most of the experiments given had been made for laboratory purposes, and had to be verified in practice. Nothing had been said as to how metal acts under direct and alternating currents. He could not answer the question himself, but put it to gentlemen who could. He would like to hear how the experiments were conducted by Mr. Preece and Mr. Cockburn, and also how long these fuses which were experimented upon were used. He maintained that a fuse made to-day to go at five amperes would not necessarily go at five if it had been in use for a long period. The fuses brought out had not always been very successful. He had used Mr. Hedges', and sometimes it had been a success and sometimes a failure. Mr. Cockburn threw over, not intentionally, but in a rather cavalier manner, certain magnetic switches made by Woodhouse and Rawson. These had been made by a gentleman who had recently joined the society, and he (Sir David) regretted he was not present to defend his interests. Of all the fuses he had ever used this was the only one that would go off at what they set it at, and it had really been invaluable to him. The reason lamps had to be protected was chiefly because they had been badly made.

Mr. Crompton said his firm had been making fuses many years, and they had got fuses in their earliest jobs which were serving their purpose now just as well as when they were first used. They found tin wire good enough for their purpose then, and with all deference he thought it was good enough for their purpose now. Tin wire put in five years ago was still unoxidised, and they did not want anything better than that. A practical question was where to put the fuse. If it was very desirable to get alongside the switch, it would be nice to have them there, but unfortunately that was not the place for the fuse. The proper place for the fuse was evidently as close as possible to the root of the branch where it left the main circuit. His experience was that there was nothing better for cut-outs than hard wood—boxwood or beech was the best. Slate was by no means a satisfactory material for the purpose. He had known a case where the substitution of slate for wooden bases for switches had reduced the insulation resistance of an installation from 12,000 ohms to 600 ohms. Slate varied very much in its insulating properties. There was more nonsense talked on this subject than anything else. The "precautions against the danger of fire" had made electrical engineers to appear very ridiculous (hear, hear).

After a few remarks from Mr. Bernstein,

Mr. Blakesley criticised some observations of Mr. Preece. He hardly agreed with giving preference to the use of shellac as a flux. He would prefer the foil to the circular wire. He emphasised the very important point touched upon by Sir David Salomons with regard to the uniformity of the current employed.

Mr. Parkinson was very much in sympathy with what had fallen from Mr. Preece and Mr. Crompton as to the use of fuses. He thought it was over-

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done. He knew a case within his own experience in which the hard wood casing, such as Mr. Crompton had described, would have served the purpose as well or better than slate.

Mr. Crookes mentioned an experimental cut-out in which advantage was taken of the thermo-magnetic properties of nickel. An electro-magnet was provided with an armature consisting of a thin strip of nickel, through which the current passed. When the temperature rose to 300deg. C. the nickel lost its magnetism, and was pulled back by an opposing spring, thus breaking circuit.

Mr. Esson endorsed all Mr. Crompton had said with regard to non-inflammable cases. There was more nonsense talked about the firing of cores than any other subject whatever. He saw no necessity whatever for placing even switches on a non-inflammable base so long as they had a proper spring. These restrictions imposed upon electrical engineers were very cumbersome to them [hear, hear].

Mr. Mordey agreed with Mr. Crompton as to the unsuitability of slate. It was not a nice substance to work, and they had found at the Brush works that it was not a trustworthy substance for high-tension working. However, he had got over this difficulty by putting it in melted paraffin. It then made an excellent insulating material. Mr. Mordey paid a warm compliment to Mr. Cockburn for his exhaustive and instructive paper.

Prof. Fleming said that many varieties of slate were impregnated with oxide of iron to such a degree that it was no wonder that their insulating qualities were greatly reduced; but some varieties, on the other hand, possessed a very high specific resistance.

Mr. Hancock having said a few words, Mr. Cockburn replied at some length on the whole discussion, and was warmly applauded.

PHYSICAL SOCIETY.

A meeting of this society was held at the Science Schools, South Kensington, on January 28, Prof. W. G. Adams, F.R.S., Vice-President, in the chair.

In opening the proceedings, the Chairman referred to the great loss which the society had sustained by the death of Dr. Balfour Stewart, their late President, and said that his loss would be deeply felt by the whole scientific world.

The following papers were read :—

On the Effect of Magnetisation on the Thermo-Electrical Properties of Bismuth. By Mr. Herbert Tomlinson.

It has been shown by Sir. Wm. Thomson and others that the electrical resistance of an iron wire is increased when magnetised longitudinally, and similar phenomena were shown to occur in steel, nickel, cobalt, and bismuth, in a paper communicated to the Royal Society in 1882 by the author. On comparing the results, it is found that for the same intensity of magnetisation the increase of resistance of bismuth is about two thousand times that exhibited by iron. The author believes the increase of resistance of bismuth to be partly *apparent* only, and thinks that some influence similar to an opposing E.M.F. is operative, but as to its exact nature he can say nothing. Hall's phenomenon suggests itself as a possible explanation, but experiment shows that this is not the true cause. The change of dimensions due to magnetisation is found to be too small to produce the effect, and, so far, no satisfactory explanation been found. On heating a rod of bismuth, when under the influence of magnetising force, an E.M.F. is set up from unmagnetised to magnetised across the hot junction, having a value of about ·0022 microvolt per 1deg. C. difference of temperature, when the magnetising force was 226 C.-G.-S. units. Ettinghausen has found that a difference of temperature is produced between the two sides of a plate of bismuth placed in a magnetic field, when an electric current is passed through it; and it has also been shown that if a thermal current be substituted for the electric current, a difference of potential is produced.

On the Influence of Magnetism and Temperature on the Electrical Resistance of Bismuth and its Alloys with Lead and Tin. By M. Ed. von Aubel. An abstract was read by Mr. Baily.

Some specimens of bismuth show an increase of resistance with temperature, whilst others shew a decided decrease. M. Righi is of opinion that the decrease is due to the presence of tin, but the author's experiments on alloys show that this is not the case. Magnetism always produces an increase of resistance, but its influence diminishes as the temperature rises. It is concluded that the cause of the anomaly is still to seek.

On a Water-Dropping Influence Machine. By Prof. S. P. Thompson, D.Sc.

In this apparatus only one jet of water is required, and satisfactory results are obtained without special insulation. It consists of three cylindrical metal vessels hung vertically over each other by silk strings, the highest and lowest being connected by a stiff metal wire. The highest is a small cylinder, open at both ends; the lowest is an open pot, which receives the water. The intermediate vessel is open at the bottom, and is provided at the top with a funnel, fixed so that its central aperture is about the middle of the cylinder. The water jet, which must have a fine orifice, is inserted about half-way into the uppermost vessel.

On the Price of the Factor of Safety in Lightning Rods. By Prof. S. P. Thompson.

It is here shown upon certain assumptions that the factor of safety against fusion varies as—total cost $\times \frac{fs}{\rho d l^2 k}$, where f = temperature of fusion of material above atmosphere, s = specific thermal capacity, ρ = specific electric resistance, d = density, k = cost in pence per lb., and l = length of the conductor. If the total cost and length are supposed to be given, the factor of safety $= \frac{fs}{\rho d k}$. Of the common metals neglecting self-induction, iron has the greatest factor of safety, being more than four times that of copper. Such being the case, the author thinks it desirable that the report of the Lightning Rod Conference be reconsidered.

On the Optical Demonstration of Electrical Stress. By Prof. A. W. Rücker, F.R.S., and Mr. C. V. Boys.

A number of lecture experiments were shown illustrating that electrical stress exists in the dielectric separating two charged bodies. The bodies were placed in carbon bisulphide, between two crossed Nicols, and on electrifying them by means of a Holtz machine light passed through the analyser. Two concentric cylinders gave a black cross on the screen similar to those seen on interposing a plate of some uniaxal crystal, and a model illustrating a charged Leyden jar was shown.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

932. R. H. Thompson and B. W. Warwick. London. Improvements in the construction of portable primary batteries adapted to medical and other appliances. January 21, 1888.

933. F. Bosshardt. London. Improvements in contact regulators for electric clocks (L. Bouchet, France). January 21, 1888.

980. W. Balch. Clapton. An improvement for the construction of electric battery cells for lighting or other purposes. January 21, 1888.

981. C. Spratt. London. Improvements in electric "call" signal apparatus. January 21, 1888.

984. W. F. Burleigh. London. Improvements in controlling railway signal levers by the application of electricity. January 23, 1888.

1,009. J. H. Davies. London. Improvements in dynamo-electric machines. January 23, 1888.

1,024. L. S. M. Pyke and H. T. Barnett. London. Improvements in and connected with electric coils. January 23, 1888.

1,029. A. Wunderlich. London. Improvements in rotary galvanic batteries. January 23, 1888.

1,055. R. J. Jones and A. Wright. Hampstead. An electric safety apparatus. January 24, 1888.

1,078. S. Bergmann and J. T. Dempster. Improvements in switches for making and breaking electrical circuits. January 24, 1888.

1,016. A. M. Taylor. London. An improvement in electrical transforming apparatus. January 23, 1888.

1,091. A. Aird. London. An improvement in or connected with counting or recording mechanism and electricity. January 24, 1888.

1,100. G. Downing. London. Improvements in electrical brazing and soldering (E. Blass, Germany). January 24, 1888.

1,128. A. A. Fortin. London. Improvement in galvanic batteries. January 25, 1888.

1,173. B. Scheithauer. London. Improvements in electric induction apparatus. January 25, 1888.

1,177. E. E. Mandeville. London. Improvements in means for supporting or suspending elements in electric batteries. January 26, 1888.

1,210. E. Andreoli. London. Reversible chlorine batteries (P. A. Ficnet and A. L. C. Nodon, France). January 26, 1888.

1,213. J. T. Leighton. London. Improvements in the application of electricity to spectacle frames. January 26, 1888.

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COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

January 28, 1888.

747. F. WYNNE. London. Means or apparatus to be employed in the application of electricity to propel vehicles on roads with or without tram or other rails. January 17, 1887.

949. G. PERCIVAL. Cork. An electrical switch or circuit closing and interrupting device of improved construction. January 21, 1887.

2,419. F. BOSSHARDT. London. Improvements in dynamo-electric machines (A. L. Hillaire-Desbois, France). February 16, 1887.

4,546. C. D. ABEL. London. Improvements in dynamo-electrical machines in combination with motor engines (the firm of Siemens and Halske, Germany). March 26, 1887.

4,553. W. DICKENSON. London. Improvements in electric telegraph apparatus. March 26, 1887.

4,914. R. D. SMILLIE. Glasgow. Improvements in switches for making and breaking electric circuits. April 2, 1887.

7,530. J. G. STATTER. London. Improvements in electrical transformers.

15,858. W. MAIN. London. Improvements in dynamo-electric machines and electro-motors. November 18, 1887.

16,032. W. MAIN. London. Improvements in electro-motors and dynamo-electric machines. November 22, 1887.

PATENTS SEALED.

January 20, 1888.

12,833. A. LOISEAU and O. PIERRARD. Paris. Automatic apparatus for subjecting the person to the action of electric currents. August 18, 1886.

15,325. J. TAYLOR and G. E. TUCKER. London. An improved electric shade-holder with single-balance weight. November 24, 1886.

205. W. CHADBURN. Liverpool. Improvements in electrical communicating apparatus, applicable for use in navigable vessels. January 6, 1887.

254. W. CHADBURN. Liverpool. Improvements in electrical communicating apparatus, partly applicable to pneumatic and other like communicating apparatus. January 7, 1887.

564. H. H. LEIGH. London. An improved electric motor (J. L. Clerc, Paris). January 13, 1887.

565. H. H. LEIGH. London. An improved electric transformator. (J. L. Clerc, Paris.) Janucry 13, 1887.

8,076. R. T. TURNBULL. London. Improvements in holders for incandescent electric lamps. June 4, 1837.

12,636. L. E. BATHRICK. United States. Improved means for discharging electricity from paper and other materials while being operated upon in printing and other machines. September 17, 1887.

12,752. A. J. BOULT. London. Improvements in underground conduits for electric railway and other appliances (E. E. Ries, United States). September 20, 1887.

13,864. F. H. ROYCE. Manchester. Improvements in incandescent electric lampholders and other like fittings. October 13, 1887.

13,974. A. SIEGMANN. London. An improved electric alarm for varying levels and pressures (C. Marohn, Germany). October 14, 1887.

January 24, 1888.

15,722. J. Y. JOHNSON. London. Improvements in electric telegraphs (A. M. Rosebrugh, Canada). December 1, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

15,344, 1886.—A. M. CLARK (The Electrotechnishe Fabrik, Cannstatt). Automatic switch and governor for electric lighting purposes. (Price 8d.)

17,120, 1886.—R. E. B. CROMPTON and J. SWINBURNE. Dynamo electric machinery. (Price 8d.)

3,998, 1887.—F. J. CHARY. Applying electric light for photographic purposes. (Price 8d.)

1,654, 1887.— W. KINGSLAND. Closing secondary battery cells. (Price 8d.)

2,851, 1887.—T. PARKER. Automatic switch for electric circuits. (Price 8d.)

3,197, 1887.—Sir D. L. SALOMONS and OTHERS. Secondary batteries. (Price 6d.)

4,478, 1887.—C. MAYNARD. Supporting telegraph, &c., wires. (Price 8d).

16,669, 1887.—M. BAILEY and J. WARNER. Combined secondary battery and miner's lamp. (Price 6d.)

16,728, 1887.—Incandescent electric lamps. (Price 6d.)

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).

Report of the Directors to the ordinary general half-yearly meeting of the proprietors, to be held at Winchester House, 50, Old Broad-street, E.C., this day (Friday), the 3rd inst., at 2 o'clock p.m. precisely:—

1. The total receipts from the 1st July to the 31st December, 1887, including the estimated balance of £18,323. 6s. 8d. brought forward from the last account, are estimated at £113,283. 6s. 5d. This amount, however, is subject to revision upon settlement of the accounts for the year with the Paris-New York Telegraph Company. The traffic receipts show an increase of £9,460, as compared with the corresponding period of last year.

2. The total expenses of the half-year, including repair of cables, &c., as as shown by the revenue account, amount to £49,638. 8s. 1d.

3. Interim dividends of 7s. 6d. per cent. on the ordinary stock and 15s. per cent. on the preferred stock were paid on the 1st November last, absorbing £26.250, leaving an estimated balance of £37,344. 18s. 4d., out of which the Directors recommend the proprietors to declare final dividends of 10s. per cent. on the ordinary stock, and 20s. per cent. on the preferred stock, amounting to £35,000, making a total distribution for the year ended the 31st December, 1887, of £1. 7s. 6d. per cent. on the ordinary stock, and £2. 15s. per cent. on the preferred stock, leaving an estimated balance of £2,344. 18s. 4d. to be carried forward to the next account.

4. The Company's repairing ss. "Minia" has been engaged during the past half year in the repairs of the Duxbury, Brest, and North Placentia cables, which were effected on the 28th August and the 12th and 20th September respectively. The Brest-St. Pierre cable, broken on the 9th November, 1886, at a distance of 600 miles from St. Pierre in 2,750 fathoms, was picked up on the 6th of August, 1887, in 2,300 fathoms, communication being restored on the 12th September as above stated—220 miles of new cable were used in this repair. Considerable damage was sustained by the ship in a cyclone during these operations, involving the necessity of her going to New York to refit. The Duxbury cable was again broken on the 2nd of September off Canso, Nova Scotia, on this occasion by the ss. "Pouyer-Quertier, which was at the time engaged upon the repair of one of the Commercial Company's cables. That company at once gave orders to the master of the "Pouyer-Quertier" to repair the cable which he had inadvertently broken, and the work was effected on the 12th of the same month. During the repairing operations off Valentia, Ireland, in December, 1886, it was found that from the rocky nature of the coast at the landing-place of the cables the shore ends had become so greatly damaged by the action of the sea that their renewal and removal to a more suitable locality was absolutely necessary. New shore ends were accordingly laid into Cooscroom, Dingle Bay, which has the advantage of a sandy bottom. The alterations were carried out in the month of September last without interruption to the communication. The 1873 cable was broken in Trinity Bay, Newfoundland, on December 9, but was repaired within twenty-four hours by the officials of the station at Heart's Content.

5. The Company's system of cables and land lines is in good working order, with the exception of the Brest St. Pierre cable, which the Directors regret to report was again broken on October 4 last, at about 1,034 miles from Brest, in a depth of 1,500 fathoms, and at a distance of 1,000 miles east of the previous break. The ss. "Minia" will proceed to the repair of this interruption in the spring.

6. The action brought by the Company against the Paris-New York Telegraph Company, to compel that company to resume performance of of the joint-purse agreements of 1880 and 1882, which they had ceased to carry out since the 31st December, 1886, was argued before the Paris Tribunal of Commerce on the 12th December last. The judgment of the Tribunal was pronounced on the 9th ult. in favour of this Company, with damages of 2,000fr. per day from 31st December, 1836, to the date of service of the judgment. The Tribunal also condemned the defendants to pay 5,000fr. per day from the service of the judgment, for one month, when the Court will decide as to future damages, unless in the meantime the defendants have resumed fulfilment of the agreements, or obtained from the Courts which, according to their concession, should determine the question, a decision that such agreements are illegal. The Paris-New York Telegraph Company are also to pay the costs of the action. They have announced their intention to appeal.

7. In the autumn of last year lengthened negotiations took place in New York between the Western Union Telegraph Company and the Commercial Cable Company (Mackay-Bennett cables) with a view to the purchase or lease of the latter company's cables. The terms demanded by the Commercial Cable Company, however, were of such a character as to preclude their acceptance. During the progress of the negotiations, the representatives of the Commercial Company threatened that unless their terms were agreed to they would immediately adopt the 6d. rate. It is almost needless to say that the joint-purse companies were prepared for this declaration, as they fully anticipated it when they commenced that rate. The Commercial Company reduced their tariff from 1s. to 6d. per word on the 15th of September.

8. The traffic passing over the lines of the joint-purse companies during the past half year shows an increase of 12 per cent. over that of the corresponding period in 1886, the tariff being the same, viz., 6d. per word—and an increase of 162 per cent. over the same period in 1885, when the tariff was 1s. 8d. per word. The adoption of the low rate by all the companies has resulted in a very considerable augmentation of the total Atlantic traffic, but it is as yet unremunerative.

9. The project of the International Cable Company, which was launched in 1886, for the purpose of laying cables between Europe and North

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America, &c., *viâ* the Azores, still remains in abeyance. At a recent meeting of the shareholders of that company, it was decided to postpone further action for six months, in anticipation that the low rates of the existing Atlantic Cable Companies would shortly come to an end.

10. In accordance with the Articles of Association two Directors of the Company, Sir Daniel Gooch, Bart., and Mr. F. A. Bevan, retire at this meeting, and being eligible offer themselves for re-election.

11. Mr. Joshua Dean and Mr. Francis Glass, the auditors, also retire, and offer themselves for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 13th January amounted to £3,879, and to £3,023 for the week ended 20th January.

THE CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY.—Mr. J. H. Buckingham, of No. 93, Wood-street, Cheapside, has joined the board of the Consolidated Telephone Construction and Maintenance Company (Limited).

MEXICAN TELEGRAPH COMPANY.—The gross earnings for 1887 are returned at $267,259, as against $221,002 in 1886, or an increase of $46,257. The net earnings were $207,015, as compared with $162,328, showing an increase of $44,687. A quarterly dividend of 2½ per cent has been declared.

SUBMARINE TELEGRAPH COMPANY.—The accounts for the half-year ended December 31, 1887, show a balance which enables the directors, after adding 15 per cent. of the gross receipts to the reserve fund, to recommend a dividend at the rate of 15½ per cent. per annum, the same as a year ago.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended January 13 were £2,875, and for the week ended January 20, £1,722, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

It is stated that the business of Messrs. Willans and Robinson, of Thames Ditton, Surrey, engineers, has been transferred to a limited company of the same name, with a capital of £200,000 in 4,000 shares of £50 each. The first issue of 1,200 shares has been subscribed by the partners and their friends, and no shares are offered to the public.

We are requested to state that Messrs. Appleton, Burbey and Williamson will shortly commence business as electrical engineers and contractors at Balmoral-buildings, Queen Victoria-street, E.C.

The partnership between Messrs. S. Brierly and W. Banks, of 32, Corporation-street, Bolton, has been dissolved, but the business is now carried on at the same address, under the title of The Bolton Science Depot, with Mr. Banks as manager.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Feb. 1.	Business Done Week Ending Feb. 1. Highest.	Lowest.	Rate per cent. Yielded. £ s. d.
Anglo-American	40, 41	42½	40¾	3 5 6
Do. Preferred	67, 68	69½	66½	3 19 9
Do. Deferred	14½, 15½	15⅞	14⅝	—
Brazilian Submarine	12, 12¼	12 1/16	11 15/16	4 18 0
Cuba	12½, 13	13	—	6 3 2
Do. Preference	18, 19	—	—	5 5 3
Direct Spanish	3¾, 4¼	—	—	—
Do. Preference	8½, 9½	—	—	—
Direct United States Cable	8⅞, 9⅛	9 5/16	8 15/16	4 5 4
Eastern Telegraph	11⅜, 11⅝	11⅝	11¼	4 15 8
Do. 6 per Cent. Preference	14¼, 14¾	14½	—	4 1 4
Do. 5 per Cent. Debentures, 1899	106, 109	—	—xd	3 18 0
Eastern Extension	12¼, 12½	12½	12 5/16	4 15 8
German Union	9, 9½	—	—	6 6 3
Globe Telegraph and Trust	5⅝, 5⅞	5⅞	5 11/16 xd	4 18 0
Do. Preference	13⅜, 13⅝	13 9/16	13 5/16 xd	4 8 0
Great Northern	13¾, 14¼	14	—	5 5 6
Indo-European	38, 40	—	—	6 5 0
London Platino Brazilian	4¾, 5¼	4⅝	—	—
Reuter's	7¾, 8¼	8¼	—	7 6 3
Submarine	140, 150	—	—	9 6 8
West Coast of America	5, 5½	5 5/16	5⅛	4 11 3
Do. Debentures	111, 116	—	—	—
West India and Panama	¾, 1	⅞	—	—
Do. 1st Preference	9½, 10	9⅞	9¾	7 10 0
Western Brazilian	9, 9¼	9 5/16	9⅛	7 15 6
Western Union 7 p.c. 1st Mortgage	120, 125	—	—	5 12 0
Do. 6 p.c. Sterling Bonds	101, 104	105	—	5 15 5

TELEPHONES.

Companies.	Closing Prices. Feb. 1.	Business Done Week Ending Feb. 1. Highest.	Lowest.	Rate per cent. Yielded. £ s. d.
Consolid. Telephone and Maintenance	9/16, 11/16	¾	⅝	5 9 0
Oriental	¼, ⅜	—	—	—
United Telephone	13, 13½	14 1/16	12	5 6 6
United River Plate Telephone	4¾, 5¼	—	—	—

ELECTRIC LIGHT.

Companies.	Closing Prices. Feb. 1.	Highest.	Lowest.	Rate per cent. Yielded.
Anglo-American Brush Light (£3 paid)	3, 3½	—	—	—
Do. (fully paid)	4, 4½	4⅜	4⅛	—
Swan	1½, 1¾	1¾	1⅝	—
Maxim-Weston	3/16, 5/16	—	—	—

MISCELLANEOUS.

Companies.	Closing Prices. Feb. 1.	Highest.	Lowest.	Rate per cent. Yielded.
India Rubber, Gutta Percha and Telegraph Works	16, 18	20½	16	7 18 0
Telegraph Construction	38, 39	39	38⅜	6 3 0

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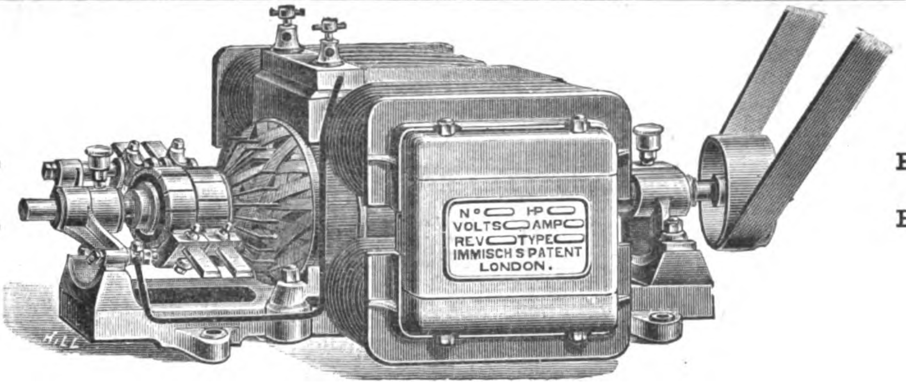

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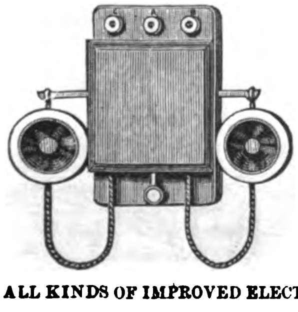

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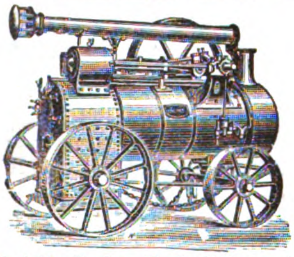

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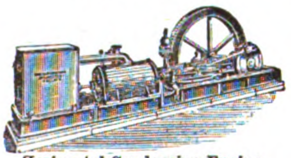

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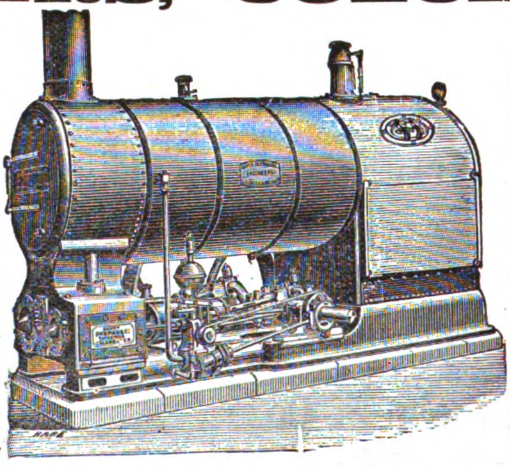

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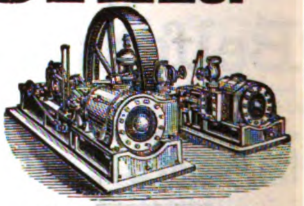

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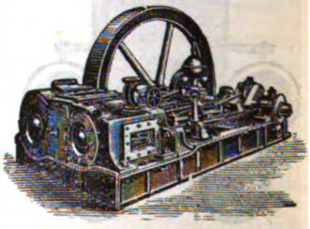

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 508.—Vol. XX. FRIDAY, FEBRUARY 10, 1888. Price 4d.

NOTES.

We are glad to learn that the Council of the Society of Telegraph-Engineers are taking steps to bring together members of the electrical engineering profession desirous of taking part in the Paris Exhibition of next year. A preliminary meeting is announced for Monday next, 3 p.m., at the Society's office.

Mr. Kapp's paper read last night before the Society of Telegraph-Engineers and Electricians contains the first serious attempt to deal with the construction of transformers upon a thoroughly scientific basis. As such it will certainly take classic rank, as the author's paper on the "Pre-determination of Dynamo Characteristics" has already done. Although the subject is treated in the lucid and unpretentious style which is characteristic of the author, yet the paper is one which will take a good deal of careful studying before being thoroughly mastered. We should, nevertheless, strongly recommend everyone who is anxious to keep pace with the modern developments of electrical engineering to make it a point to understand, at least, the general method of treatment adopted, and particularly the passages relating to the magnetic density. Some of the conclusions arrived at will surprise most people, particularly the establishment of the slight theoretical inferiority of the Zipernowski type—or "shell type," as Mr. Kapp proposes to term it.

The enormous stride which has been made in electrical engineering during the last five years is nowhere more strikingly disclosed than in this matter of transformers. When we contrast a Gaulard-Gibbs "secondary generator" of 1883 with any of the modern types we are impressed not so much with the difference of constructive details in themselves as with the advance which has been made in the general appreciation of the principles involved. The idea of a transformer with a long straight iron core, or with no core at all, seems now almost preposterous; yet M. Gaulard was at that time practically the only man who recognised the possibilities of this simple development of Faraday's great discovery. If we are not mistaken it was a suggestion of Mr. Esson's, in 1885, which first led to the adoption, by Messrs. Gaulard and Gibbs, of a closed magnetic circuit; and even now it is scarcely two years ago that the advantage of keeping the magnetic circuit as short as possible was fully recognised.

During the recent tests which were carried out by Prof. Weber on the Oerlikon plant, employed for the transmission of power between Kriegstetten and Solothurn, great attention was paid to the loss of current by leakage, or we should rather say that great efforts were made to discover the leakage; only, as it turned out, there was no loss of current and no leakage to discover. The current at the far end of the line—a distance of eight kilometres—so far as the instruments were able to detect, was of absolutely the same value as at the starting point. Seeing that the potential in these experiments sometimes exceeded 2,000 volts, this result will be considered as remarkable as it is satisfactory. The result was attained by the use of the well known "fluid insulators" of Johnson and Phillips. In a letter to the firm —of which we have a copy—Prof. Weber lays stress on the extreme care which was taken in the measurements, and says that the result is that this method of insulation is proved to be simply *perfect*. It would be difficult to over-estimate the importance of this matter as regards the future of the long-distance transmission of energy. It has long been recognised that the employment of high potential in such a case is an absolute necessity, and it follows as a corollary that a "perfect" method of insulation is necessary. Fortunately we now know that this is already available.

Prof. Elihu Thomson's ingenious method of rendering visible the form of an alternating current wave is probably capable of improvement in detail. At present it is difficult to know how much importance should be attached to the distortion introduced by the diaphragm and the multiplying levers. If levers are employed at all, probably a better plan would be that adopted by Tyndall for rendering visible to an audience the expansion of a bar of lead with increase of temperature. This is very fully described and illustrated in "Heat, a Mode of Motion" (page 90, 6th edition). It seems, however, quite possible to obtain good results in a less complicated manner. Why not mount the mirror upon a free reed vibrating in front of the magnetic pole? In this case the compounding of two currents to note the phase difference could be very easily carried out after Lissajous's method of compounding the vibration of tuning-forks. That is to say, two electro-magnets with reeds and mirrors would be placed at right angles to one another at some little distance apart; a beam of light would be reflected from the first mirror to the second and thence to a screen. If the phases and periods were the same the ray would trace a right line on the screen,

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and this would open out into an ellipse, and finally into a circle as the retardation increased (in the case of a transformer as the resistance in the secondary circuit is increased). This would clearly be better than Prof. THOMSON'S method of mounting the mirror in gimbals.

IF this method were adopted, it would become an important question to determine the proper form of reed to employ in order to get the most accurate results. Supposing that the shape of the current wave were absolutely solenoidal no doubt it would be best to tune the reed to a note having a period corresponding to the period of alternation; but Prof. ELIHU THOMSON'S results have shown already that the actual current wave may have a very irregular shape. It would, perhaps, be right to use a long reed so arranged that its vibrations were forced. But this is a question for the mathematicians. It is worth while to note that from the optical conditions it would not do to reflect the ray from the polished end of the magnet itself—or from a mirror directly fastened to it—even supposing that the magnetic elongation of the iron were much greater than it really is. In LISSAJOU'S experiments it is not the to-and-fro motion of the prongs that is brought into play, but their angular deviation. The experiment is easily made in the form which we have suggested, and we should be glad to hear from any of our readers who may think it worth while to attempt it.

WE also happen to know that an English electrician some time ago devised a method for causing an alternate current machine actually to record its own current wave in a permanent form. The apparatus has not yet, however, been made, and we do not know that we are at present at liberty to describe it. The method is of a most ingenious character, and we see no reason why it should not fully answer its purpose.

HAVING made up their minds to alter the title of their Society, the Council of TELEGRAPH-ENGINEERS AND ELECTRICIANS are acting wisely in taking prompt steps to obtain the written sanction of its members for the change. The INSTITUTION OF ELECTRICAL ENGINEERS is, all the circumstances considered, the best title that could have been chosen, and it is pretty sure to prove attractive. Whatever objections were likely to be raised among the purely telegraphic element of the Society have been fairly met in the circular just issued by its secretary. No opposition seems to be apprehended from any other quarter; and, except on sentimental grounds, probably none will be offered.

THE growth of public opinion in favour of removing the legislative restrictions on electric lighting industry could not be better illustrated than by the fact that the gas lighting journals are beginning to condemn the Act of 1882. One of them last week went so far as to recommend the extension of the present twenty-one years' limit to forty years. The conclusion being sound, we ought not to look too closely at the process of reasoning by which it is reached; but it will strike our readers as singularly inappropriate for an organ of gas lighting monopolies to allow itself to digress into the following strain when lighting by electricity is being discusssed: "Legislation," says the *Gas World*, "is progressive. The framers of laws in these days are not bound by the Acts of their predecessors. While these Acts, so far as they relate to the supply of gas, will not be abrogated, the House of Commons and the House of Lords will hesitate ere they grant authority to measures which practically confer monopolies upon recipient companies, and, to a certain extent, sacrifice the interests of the public." On this we have only to remark that, if it be true—which we deny—that the interests of the public are sacrificed whenever monopolies are conferred, "progressive" legislation of the kind which insists on buying up a terminable monopoly for an old song is not likely to spare the perpetual monopolies when their turn comes. The gas and water companies, whose immense interests some day may be threatened by legislation of that sort, ought to make common cause with us in resisting rather than condoning this "progressive" tendency.

PAPERS like that read by Mr. GEIPEL at the Institution of Mechanical Engineers on Thursday week are just what is wanted from time to time. His paper does not profess to contain any information which will be new to the electrical engineer, but rather to place before his mechanical brethren a plain matter-of-fact statement of what is now being done in everyday work by electrical means. A new thing in electricity has but very little interest to the mechanical engineer, as such. What he wants is something solid, which has been proved in hard regular work, and found a commercial success, and it is just such applications that Mr. GEIPEL deals with.

NOT so very long ago there existed among electrical engineers a more or less undefined feeling that the older branches of the engineering profession were disinclined to take them sufficiently seriously, and looked upon them rather in the light of enthusiastic amateurs. And when the force of accomplished facts rendered it impossible any longer to take this ground, it was still felt that there was a disposition to regard the electrical engineer rather as an interloper and an upsetter of established methods of procedure than a welcome ally. But from the proceedings of the Mechanical Engineers on Thursday and Friday last week, it is abundantly evident that a truer appreciation of the relation between these branches of the profession is making rapid headway. The fault—if that is not too harsh an expression for what is, after all, a perfectly natural and necessary course of development—has, undoubtedly, existed on both sides. Electricians have sometimes been inclined to talk a little extravagantly about "the coming age of electricity;" but it is now widely recognised, and will be recognised more and more, that electricity as applied to mechanics is merely an agent—an invaluable agent it may be —for the transmission of energy; and as such it will take its true position amongst the other potent agencies which science places at the disposal of the mechanical engineer. We hail the discussion on Mr. GEIPEL'S paper as a significant mark of the progress of these views, and of the more extended use by mechanical engineers of the electrical transmission of energy.

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THE Financial Press is still convinced that telephone shares ought to go up, and they do go up accordingly. This is no doubt very satisfactory; but if the maintenance of these prices is to depend on the early fulfilment of the predictions on which the rise is based, perhaps the case is not so satisfactory as it looks. The *Weekly Bulletin*, like the *Financial News*, is confident the POSTMASTER-GENERAL has a Bill in his pocket for the purchase of the telephone companies. We are equally confident he has not. If possible, we are still more confident that he has no notion, as the first-named paper suggests, of handing, as an alternative, the Post Office telephone business over to the companies—at all events not if that proceeding would mean washing his hands of the telephone business altogether, royalties included. But perhaps the financial organs have forgotten all about the royalties in this relation.

Acton.—The Lighting Committee of the Acton Local Board has under consideration a proposal from the American Electric Manufacturing Company to supply electric light in that district.

The "Sunbeam" Lamp.—We understand that Messrs. Sydney F. Walker and Olliver, of Cardiff, who are the agents for the Sunbeam lamp in South Wales, have recently introduced the lamp with success in several collieries.

A Correction.—Mr. Herbert Tomlinson writes us to state that the German physicists who have recently investigated the thermo-electric properties of metals in a magnetic field are named Ettinghausen and Nernst. The *Journal de Physique* is, however, originally responsible for the spelling which we inadvertently adopted.

Royal Society of Antiquaries.—We understand that the electric lighting at the Royal Society has been extended to the premises of the Society of Antiquaries, where a total of 110 lamps is fixed. Thirty-three of Drake and Gorham's improved L31 cells in glass boxes are employed in connection with this extension, also one of their main switch-boards fitted with ring contact-switches.

Leeds.—At a meeting of the Electric Lighting Committee of the Leeds Corporation, on Thursday, it was decided to place 100 incandescent electric lamps in the mayor's rooms at the Town Hall. The arrangements for an installation to light the Fine Art Gallery, the Victoria Hall, and all other parts of the Town Hall and municipal buildings are to be considered by the committee shortly.

The Lighting of the Temple.—We understand that the Benchers of the Temple have decided to carry out a scheme for lighting the whole of their extensive domain by electricity. The Library has been so lit for some time past, and temporary installations have been carried out in the grounds and in the church on several occasions. The occupiers of chambers are also trying to get a telephone for their common use in each house.

"Annual Export Catalogue of Machinery and Hardwares." We have received from the Machinery and Hardware Company (of 147, Queen Victoria-street, E.C.) a copy of the third issue of their "Annual Export Catalogue of Machinery and Hardwares by the Principal Makers in Great Britain." The advantage of this method of advertising seems to be fully appreciated by many of the most important engineering firms; but electrical engineers are at present represented by a single firm. The catalogue is well indexed, and is printed and got up in a very creditable style.

The Lighting of Exeter.—The *Western Morning News* says:—"The lighting of the streets of Exeter by electricity is a decided success. The arc lamps are hung at a much greater height, on poles, than was the case when a few trading establishments were being illuminated some weeks ago, and the result now is that the light is not nearly so dazzling to the eyes. It is spread over a wider area, and gives perfect satisfaction. The whole of High-street is thus lit, and most of Queen-street. The gas has been put out on certain nights, and the electric light tried by itself with great advantage."

Messrs. Ransomes, Sims and Jefferies' New Catalogue.—We have received from Messrs. Ransomes, Sims and Jefferies, of Ipswich, a copy of their new Catalogue and Price List of Steam Engines. The catalogue contains drawings and particulars of several new types of engines, both portable and stationary. Our readers are aware that this firm has paid special attention to the production of engines adapted for electric lighting. On page 46 we find illustrated a special portable engine made for driving a dynamo, which is mounted on a bracket in front of the smoke-stack. This plant should prove very useful for contractors or any kind of temporary lighting.

American Carbons.—Referring to our recent remarks on this subject, the New York *Electrical Review* says:—"We have long ago learned the truth that a carbon giving fine results, say, in a Thomson-Houston lamp, behaves villanously in a Brush lamp; and in the evolution of the systems, the carbon makers of this country have done a vast amount of experimenting to establish *grades*, which should be adapted especially to the respective systems—grades which do not differ in price or quality, but do differ materially in character as to hardness, temper, &c. But it by no means follows that because a particular carbon misbehaves in a given lamp it is inferior; it is simply in the wrong lamp. If some of the English plant owners will bear this in mind, they may yet bless the 'cheap American carbons.'"

Trade Conferences at Finsbury Technical College.—A series of conferences of the representatives of various trades and handicraft industries is now being held at the Finsbury Technical College. These began last autumn, with two general conferences on technical education. The third conference, which was for the cabinet-making trade, and was attended by a large and very representative audience, was held on January 14th last. The next conference, which is for bricklayers, is to be held on Wednesday, February 15th, when Mr. James Rowlands, M.P., will preside, and a paper "On the Technical Education of Bricklayers and Brickcutters" will be read by Mr. H. W. Richards. This will be succeeded on the 18th inst. by another conference of carpenters and joiners, under he presidency of Mr. W. R, Cremer, M.P.

The Telegraph Manufacturing Company's Trade Catalogue. The Telegraph Manufacturing Company, of Helsby, sends us a copy of a new catalogue of electrical apparatus which they have recently issued. This catalogue contains a very complete list of electrical apparatus (*outside* the department known as "heavy electrical engineering," but) including all kinds of wire, bare and covered, insulators of every description, iron and wood poles, and linemen's tools. In other sections we have batteries and instruments of various types, including railway and block instruments, testing apparatus, bells and annunciators, fire alarms, &c. The firm write us that they "have endeavoured to make the catalogue as complete as possible in every section, so that contractors may have in this a *vade mecum* easily carried in the pocket for estimating for telegraph, telephone, bell, and

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other work." This intention has certainly been carried out thoroughly.

The Telegraph Lines between England and Germany.—A Reuter's telegram, dated Berlin, February 8, says :—"In to-day's sitting of the Budget Committee of the Reichstag, during the discussion of the proposed purchase of the telegraph cables between Borkum and Lowestoft, and Greetsiel and Valencia, Dr. Von Stephan, the Postmaster-General, declared that it was intended to make a considerable reduction in the telegraph rates between Germany and England, after the agreement on the subject had come into force, which would be on January 1 next. The charge for the grundtaxe, at present amounting to 40 pfennige, would be abolished, and the rate per word, which is at present 20 pfennige, would be reduced to 16 pfennige. The Minister added that the British Government would take over the Borkum-Lowestoft line, and establish direct communication with London and the more important towns of England. The agreement was unanimously approved by the committee."

Train Lighting by Electricity.—The Great Northern Railway Company has now four trains running from King's Cross in which, under the direction of Mr. James Radcliffe, the telegraph superintendent of the line, a very efficient electrical plant has been fitted, and a fifth installation is in preparation for an express train to Edinburgh. A dynamo and set of accumulators are placed in the van under charge of the guard. The machine is a Brush, shunt wound, giving from 45 to 90 amperes of current, according to the speed at which the train travels. This is driven from the axle of the train wheels, multiplication of speed being obtained by means of counter-shafting. The direction of rotation of the dynamo is regulated by an arrangement designed by Mr. Radcliffe, by which the dynamo is always driven in one direction, whichever way the train may be running. The accumulators are connected with and disconnected from the dynamo by means of an automatic switch, also designed by Mr. Radcliffe.

Bournemouth.—A meeting of postal and telegraph officials was held at the Waverley Hotel, Bournemouth, on Tuesday night, Mr. F. A. K. Haunsell, A.S.T.E., in the chair, Mr. W. H. Childs vice-chair. The Postmaster (Mr. Dunn) was highly eulogised by both branches. Mr. Lynd, the editor of the *Telegraphist*, proposed the "Engineering Department of the Postal Telegraphs," coupling with it the names of Messrs. Graves, Preece, and Kempe. After giving a brief sketch of the early days of telegraphy, Mr. Lynd said that the labours of such men as he had named had made telegraphy one of the most perfect popular institutions in the world. The number of messages dealt with at the Bournemouth office last year amounted to two hundred thousand, showing an increase of twenty-one thousand on the previous year. A telegram was received from the Secretary of the Postal Telegraph Clerks' Association during the evening, urging the staff at Bournemouth to join in the struggle for their modest demands.

Lighting of a Yacht.—The steam yacht "Victoria," which sailed from Gravesend on the 4th inst. for a cruise of three months in the Mediterranean, has just been fitted with a new electric light plant, by Messrs. Browett, Lindley and Co., of Manchester. The plant consists of 150 incandescent lamps and an F 2 Victoria Brush dynamo, driven direct at 200 revolutions by a new type of vertical tandem compound engine, recently brought out by the above firm. The installation of the generating plant presented some difficulties, as the whole had to be carried on a wrought-iron platform, erected for the purpose in a corner of the main engine room, and level with the top of the cylinders. The whole plant is compact and entirely self-contained, and the engine is constructed to work either as a high-pressure engine, with 50lb. steam from the donkey boilers, and exhausting into the air, for use when in port, or to work compound with steam from the main boilers, which carry 80lb. pressure, and exhausting into the main condensers.

The Lighting of the Bute Docks, Cardiff.—We reproduced last week a paragraph from a local paper which stated that a Brush plant was being installed for the lighting of the Bute Docks, at Cardiff. We have since learnt that this is erroneous, the work having been placed in the hands of Messrs. Crompton and Co. The plant consists of three Crompton machines, each capable of supplying current for 11 DD lamps of 3,000 candle-power each. Two of these machines will be in regular use, the third being kept as a stand-by. The 22 lamps now fixed are arranged on two circuits and mounted on poles 30ft. in height. Eleven are fitted with the shadowless gear which has been so successful at Tilbury and elsewhere. By means of this arrangement no deep shadows are thrown, obstructing the light where most needed in the unloading of ships, &c., and thus great advantage is derived from their use. Most of the wires are run overhead, but in crossing locks it has been necessary to encase the cable in strong sheathing and lay it across the bottom. Divers have been at this work for some time and it is now nearly completed. The switch-board is on the most improved principle, and provides for a future extension by the addition of two more circuits, making forty-four lights in all. Instruments have been attached to the switch-board for measuring and testing. The whole work is being carried out under the supervision of Mr. W. H. Massey, who is acting as the consulting engineer to the Dock Company.

The Organ at St. Paul's.—In its interesting account of the organ loft of our metropolitan cathedral, the *Daily News* makes mention of some of the uses to which electricity is applied in the conduct of the musical service. "A 7 o'clock an electric signal flashed across the cathedral from the Dean's vestry intimates that service time has arrived. Electricity plays an important part here. Already a signal has gone down to the engine room in the crypt, where an Otto silent gas engine has been started, and the swelling bellows as it raises its huge back has automatically telegraphed back 'wind on.' It has begun to blow a small hurricane through two trunk pipes leading out of 'Willis's patent cylindrical feeders.' These feeders are four cylinders, each provided with a double set of valves; two cylinders supplying a high-pressure reservoir and two low pressure. 'Wind on' has been signalled up from the engine room, and now is heard the 'whir-r-r' from the Dean's vestry to the minor canons and the choir. If the organist is not on the alert another subdued racket will be immediately set up on an electric apparatus just over his head. After the overture, if the organist has anything to say to his choir down in the stalls below, he can communicate by telegraphic wire and speaking tube. There is another apparatus here also. On great days, when an orchestra of 50 performers and a special choir of more than 300 take part in the service, an electric communication is maintained between the left foot of the conductor down in the body of the church and a movable arm which beats time close to the music book of the player."

Evening Lectures by Prof. Perry on the Design and Manufacture of Dynamos.—We have pleasure in announcing that a special course of four lectures on the mechanical engineering involved in the design and manufacture of dynamo machines and motors will be delivered at the Finsbury Technical College, Leonard-street, City-road, E.C., by Prof. John Perry,

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M.E., D.Sc., F.R.S., once a fortnight on Thursdays, at 7 p.m., commencing Feb. 16th, together with drawing office work on the same subject on the alternate Thursday evenings, from 6 to 9 p.m. The following is the syllabus:—1. Feb. 16th. Continuous current dynamos and motors in use described. Electric and magnetic rules which are now adopted, as to sizes of iron and the winding. The iron and other materials used. Where the mechanical engineer's usual methods of working must be modified. Journals. —2. March 1st. Simplicity of design. The usual causes of a breakdown. Use of machine tools. General questions of strength of parts. Armatures. The division of metal. Insulation and winding of wire, &c., on the field-magnet and armature. Lasting power and strength of joints.—3. March 15th. Forces to which the wound wire is subjected. Influence of these on design of armature. The driving of dynamos direct and by gearing. Driving from motors. Commutators and brushes, their design, insulation, strength, wear and manufacture. The electric transmission of power.—4. April 19th. Alternating current machines in use. Electric and magnetic rules. Design and manufacture in the past and probably in the future as compared with that of continuous-current machines. The past and probable future of dynamos. On the alternate Thursdays drawing office work is undertaken. The fee for this course, including drawing office work, is 6s., and apprentices are admitted at half fees.

The Electric Lighting Bill.—In *The Times* of Feb. 3 the following letter from Lord Thurlow appeared:—"The public are under a great obligation to your well-known correspondent Major Flood Page, whose letter you printed yesterday, for his very clear and powerful advocacy of the strong claims of electric lighting on the immediate attention of Parliament. As he has referred to my Bill, which passed the House of Lords last year, and expresses in very kind terms the hope that I may re-introduce it this year, I beg to say that it is my firm intention to lay it again on the table of the House of Lords so soon as Parliament re-assembles. At the same time, I entirely concur with Major Flood Page in hoping that Government may see fit to to deal with the question this Session, and enable me to withdraw my Bill and give my hearty support to their measure. The only point on which a difference of opinion practically exists in Parliament is on Clause 27 of the Act of 1882, which governs the compulsory purchase of electric lighting undertakings by local authorities after 42 years (42 years being now generally conceded in place of the original 21 years). The Board of Trade oppose any valuation of the 'goodwill' of the business. We, on the other hand, feel that nothing short of a fair valuation of that asset will insure the public being well served during, say, the last ten years of the life of a provisional order. If the valuation for compulsory purchase by a local authority at the expiry of 42 years is made on narrow principles, such as mere break-up value, without a due regard to maintaining the thorough efficiency of the plant, we hold that there is a serious danger of electric lighting undertakings being allowed to run down towards the expiry of their term, to the detriment of the public. It is, however, possible that sufficient, fair, and reasonable profits may be derived from the business during the period of 42 years to encourage the flow of capital into electric lighting undertakings which 21 years have failed to do; but we think it politic to give an electric lighting undertaking every encouragement to maintain its plant in the highest state of efficiency up to the expiry of its life of 42 years, and that for this purpose it is necessary 'goodwill' should be considered as an asset for valuation in the event of compulsory purchase by the local authority. If, on the other hand, it can be legally held and maintained that the valuation 'as a going concern' sufficiently covers this point and affords sufficient protection to the public, I for one would be glad to drop the obnoxious word 'goodwill.'"

The Society of Telegraph-Engineers and Electricians.—Proposed Change of Title.—The following circular has been issued to the members and associates of this society:—"Dear Sir: In their report to the annual general meeting, on the 8th December last, the Council stated that, 'in their opinion the title of the society, even as amended some few years ago, does not sufficiently indicate the full scope of the objects which should be, and which are, its aim, and they believe that "*The Institution of Electrical Engineers*" would be a much fitter title, as embracing more clearly all those branches of applied electrical science which of late years have assumed such prominence, and are becoming every day more important;' and they expressed their intention of taking the necessary steps for ascertaining the views of all classes of members upon the subject before submitting the proposed change of title in a formal manner to a special general meeting of members. I am accordingly instructed to request the favour of your communicating to me, on the accompanying form, as early as you conveniently can, your assent to or dissent from the proposal. The President and Council desire me to state, for the information of those members who were not present at the annual general meeting, that, judging from the manner in which the announcement of the proposal was then received, and from every other opportunity afforded them of eliciting an opinion on the subject, the suggested change has, so far, met with general opinion. There can be no doubt that the present title is inconveniently long, the consequence being that the society continues to be universally spoken of as 'the Telegraph Engineers,' with the natural result that it is still supposed by many to be a society occupying itself, as originally, almost exclusively with telegraphy; and it is a matter of common occurrence for electrical engineers, when invited to join the society, to reply that they fear they are not qualified, 'as they are not telegraph engineers.' Electrical telegraphy must always remain one of the most important applications of electrical science for the service of mankind; but it certainly is no longer, as it was when the society was first established, the *only* important one. Electric lighting, electric haulage, the electrical transmission of power, telephony, &c., are only some of the comparatively recent applications which are probably destined to rival the electric telegraph in importance, and it is evidently desirable not only that our society should deal, as indeed it does already deal, with these matters, but that its title should more clearly indicate that it is not confined to the consideration of any one of them alone. I am particularly desired to remind that still large section of the members who are either entirely or chiefly concerned in electric telegraphy, that theirs is distinctly but a branch—although a very important branch—of 'electrical engineering,' and that in these days, even more than formerly, a telegraph-engineer should be, and indeed must be, an electrical engineer. They need have no fear that their particular branch will occupy any less the attention of the 'Institution of Electrical Engineers' than it now does of the 'Society of Telegraph-Engineers and Electricians.' The President and Council believe that the tendency of the proposed change will be rather to raise the status of telegraph engineering in the world of applied science than to lessen in any way the recognition of its vast importance, and they trust that you will share their views.—I have the honour to be, dear Sir, yours faithfully, F. H. Webb, Secretary."

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THE RISE AND PROGRESS OF TELEPHONY IN THE UNITED KINGDOM.

(*Continued from page 231.*)

At the end of our last chapter it was mentioned that although the Hunnings transmitter was ultimately decided to be an infringement of Edison's patent, held by the United Telephone Company, the judgment was in the first case against the Company on a technical point, namely, the inclusion of the phonograph, which was not in the first specification. The company applied for leave to disclaim the phonograph, and the disclaimer was granted in August, 1882, some three months after the application. This established the validity of Edison's patent, and this decision was confirmed on appeal in the following year.

During the interval, however, from May to August, 1882, Edison's transmitter remained unprotected, so that all transmitters coming under his patent which might be manufactured, or *bonâ fide* contracted for, during this time could be protected by *fiat* of the Attorney-General.

During this interval the United Telephone Company came into conflict with the Globe Telephone and Maintenance Company, which used the Hunnings transmitter and the receiver mentioned in a former chapter as going by the name of the "English Mechanic" receiver. This company had been registered at the beginning of 1882, though it did not obtain the Postmaster-General's licence until January, 1883.

The United Company had printed a notice on the cover of a pamphlet, containing a list of their subscribers, parts of which ran as follows:—

"The United Telephone Company have been advised by eminent counsel that all forms of transmitters in which carbon is used in a fine or powdered form—as, for instance, in the transmitters usually known as Moseley or Hunnings—and that all the so-called microphone transmitters, including those known as the Crossley and the Gower-Bell, are infringements of Mr. Edison's patent as amended by disclaimer." And "No form of magneto telephone, and no form of transmitter in which carbon or other equivalent substance is employed, whether known as Edison's, Moseley's, Hunnings', Crossley's, Gower's, or any other name can be manufactured, sold, supplied, or used in this country except under license from the United Telephone Company (Limited). Proceedings will be taken against persons infringing the company's patents and other rights as above set forth."

The Globe Company applied for an injunction to restrain the publication of these statements, which were stated to be in the nature of a libel on the plaintiffs' patents, and the case was decided by Mr. Justice Fry, in June.

In the course of the evidence it appeared that the solicitors of the defendant company, in reply to a complaint from the Globe Company, had given an undertaking that no more copies of the pamphlet containing the statements complained of would be issued, but as this was not complied with proceedings were taken. The defendant company could only plead in excuse that the subsequent issue of the pamphlet containing the obnoxious statements had been without their knowledge.

Relations begun in this fashion could hardly be expected to become very amicable; and as a matter of fact the contest between the established company and its not very formidable rival was carried on with the bitterest animosity on both sides. The older company used all its resources to obstruct the other and prevent it from obtaining way-leaves for its wires, and the Globe Company retaliated by trying to induce the United Company's subscribers to transfer themselves to their own newly-opened exchange by offering to take them on without charge until their current subscriptions had run out. In some cases they were successful, as they were charging lower prices than the older company. The conflict even descended to quarrels between the workmen of the rival companies upon the housetops and the tying together of wires to annoy the subscribers of the rival company, and resulted in some of the officials of the Globe Company being summoned to the Guildhall on the charge of malicious damage to property, which, however, was not sustained. In the meantime, large sums of money were being spent in litigation between the companies, until the contest was brought to an end in the year 1884 by the United Telephone Company accepting the offer of the Globe Company to buy up their exchange, with all their plant and the patents on which they relied.

The Globe Company had at this time only about a hundred subscribers to their exchange, and the United Company, on effecting the purchase, carried on the exchange, without connecting it to their own system, until the subscriptions ran out, when such of the subscribers as wished it were transferred—at their own prices, of course, not those of the Globe—to the United Telephone Company's exchange.

The latter company was now left without a rival in the field, but had still to fight its way against many obstacles, such as State restrictions, the difficulty of obtaining way-leaves for overhead wires, and above all the phlegmatic indifference to everything new which is so characteristic of us as a nation. In the spring of 1885 important additional facilities were opened to subscribers by the arrangement made with the Post Office authorities to connect the exchanges with the Central Telegraph Office in St. Martin's-le-Grand, and to enable the subscribers to receive and transmit telegrams direct through St. Martin's-le-Grand, on arranging with the company for payment of the ordinary Post Office tariff for inland and foreign messages.

(*To be continued.*)

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

ALTERNATE-CURRENT TRANSFORMERS, WITH SPECIAL REFERENCE TO THE BEST PROPORTION BETWEEN IRON AND COPPER.

BY MR. GISBERT KAPP.

At the meeting of the Society of Telegraph-Engineers and Electricians, held at the Institution of Civil Engineers, yesterday (Thursday) evening, the president (Mr. E. Graves) in the chair, the following paper was read by Mr. Gisbert Kapp:—

The principle on which all induction coils, and therefore all the different forms of alternate-current transformers, depend is that of a magnetic circuit interlacing with an electric circuit. In its simplest form this relation can be represented by two rings threaded through each other (Fig. 1), one representing the electric circuit and the other the magnetic circuit. Modern transformers have all a closed core, so as to compel, as far as possible, all the lines of the magnetic circuit to pass through the electric circuit, which consists of a primary and secondary coil; but they differ from each other in the particular manner in which the circuits are arranged, with a view to attain the following objects:—Reduction of the length of the two circuits, reduction of the weight of materials employed, ventilation, facility of manufacture and repair, efficiency of insulation, and reduction of cost of manufacture. Omitting for the present those considerations which more nearly concern the practical manufacture, we may divide transformers broadly into two classes—one in which the copper coils are spread over the surface of the iron core, enve-

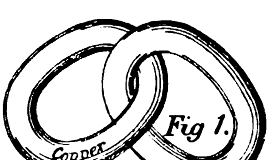

Fig 1.

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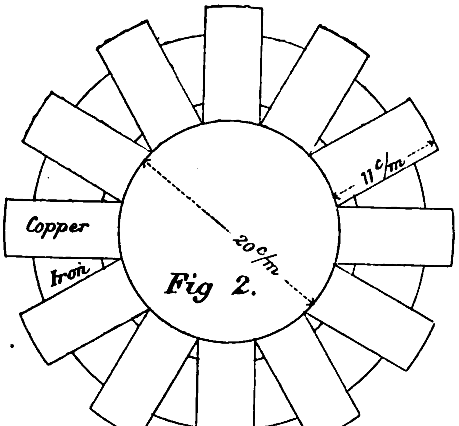
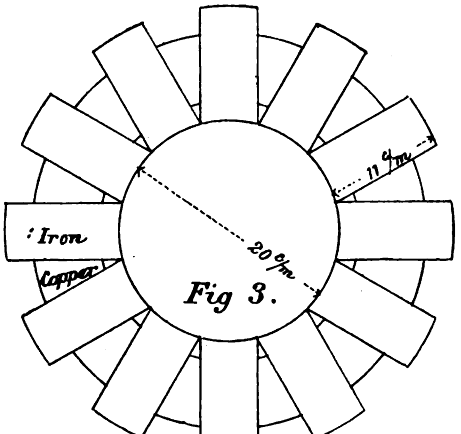
loping the latter more or less completely; and the other in which the core is spread over the surface of the copper coils forming a shell over the winding. I propose to call the former "core transformers," and the latter "shell transformers." A familiar example of the first class is the armature of an ordinary Gramme dynamo, whilst the particular type of transformer introduced by Mr. Zipernowski may serve to illustrate the second class. They are represented in the wall diagrams (Figs. 2 and 3), the copper being coloured red and the iron blue. It is evident without mathematical investigation that, whatever may be the proportion between the external and internal diameter of the ring, the electric circuit must be shorter than the magnetic circuit in the Gramme ring or core transformer, whilst the opposite must be the case in the Zipernowski ring or shell transformer. When, a few years ago, this type was introduced, it was, on account of its short magnetic circuit, generally believed to be an immense improvement upon the Gramme ring; and I have





heard it stated that with the Zipernowski outside core absolute perfection has been reached, since "every inch of copper wire contributes to produce electromotive force." I propose presently to lay before you a short investigation into the relative merits of the Gramme and Zipernowski rings, and also into the best proportion of copper to iron in either; but before entering into this subject I would submit a few theoretical considerations, so as to obtain a basis for this investigation.

Since the electromotive force developed in the secondary circuit is proportional to the coefficient of mutual induction between that and the primary circuit, and since self-induction tends to produce lag and so reduce the output of the apparatus, it is obviously advantageous, both for efficiency and output, to so arrange the coils that their coefficient of mutual induction should be a maximum for the given coefficients of self-induction in the primary and secondary circuits. According to a well-known law, the maximum value which the coefficient of mutual induction can have is equal to the square root of the product of the two coefficients of self-induction; and the necessary and sufficient condition for obtaining this maximum is that the same number of magnetic lines of force should pass through both circuits; in other words, the whole of the flow of force should take place within the core, and no free poles should be formed. This condition can easily be fulfilled by a suitable arrangement of the two circuits in close proximity, and, as a matter of fact, is fulfilled in all modern transformers. We shall therefore assume that the same flow (F) of magnetic lines of force passes through both circuits, and that the electromotive forces produced in the two circuits bear to each other the same proportion as their respective number of turns. We shall further assume that the electromotive force impressed on the terminals of the primary coil, or the current sent through it, is a simple sine function of the time—in other words, that the electromotive force developed in the armature of the dynamo is such a function. Whether the latter condition is generally fulfilled by modern machines I am unable to say; but I believe that the presence of a transformer in the circuit has the tendency to smooth down any deviations from a true sine curve should they occur in the armature, and, further, that a curve of E.M.F., of whatever shape, produced by a machine will, after filtering through two or three transformers, come out as a true sine curve. It would be of value if someone having the necessary mathematical attainments would investigate this point; but for our present purpose it is sufficient to assume that the electromotive force produced by the machine follows with fair approximation a simple sine function, and that the deviations are unimportant. This assumption has up to the present been made by all who have investigated the subject of transformers.

Let, in the following:—

n	represent the	number of complete cycles performed per second;
F	" "	flow of force in C.-G.-S. lines;
B	" "	maximum inductions (crest of wave);
τ	" "	number of turns in the coils, the indices 1 and 2 being used to distinguish the primary from the secondary coil;
E	" "	maximum electromotive forces (crest of wave) in volts, the indices 1 and 2 being used to distinguish the primary from the secondary coil;
$e = \sqrt{E}$	" "	average electromotive forces;
I	" "	maximum currents;
$i = \sqrt{I}$	" "	average currents;
L	" "	length of the magnetic circuit in centimetres;
a	" "	area of core available for the flow of lines in square centimetres;
$R = \frac{L}{a}$	" "	magnetic resistance of the core;
μ	" "	its permeability;
r	" "	the electric resistances;

then we have the following well-known relations:—

$$B = \frac{F}{a}\ ;\ F = \frac{\mu\, 4\, \pi\, \tau\, I\, 10^{-1}}{R}\ ;\ E = 2\, \pi\, n\, F\, \tau\, 10^{-3}\ ;\ \frac{E_1}{E_2} = \frac{\tau_1}{\tau_2}.$$

Calling e_{t_1} and e_{t_2} the average electromotive forces at the primary and secondary terminals respectively,

$$e_{t_1} = e_1 + r_1\, i_1\ ;\ e_{t_2} = e_2 - r_2\, i_2.$$

When a tranformer is at work we have the following phenomena:—

1. A wave of impressed primary electromotive force.
2. A wave of counter electromotive force in the primary coil, but not exactly coinciding with the impressed.
3. A wave of primary current not coinciding with either.
4. A wave of magnetisation lagging behind the primary current wave by something less than a quarter period.

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5. A wave of electromotive force in the secondary coil lagging behind the magnetisation wave by a quarter period.
6. A wave of secondary current, coinciding with the former (5) in period if the external circuit contain no self-induction—a condition approximately fulfilled where the current is only used for lighting glow lamps.

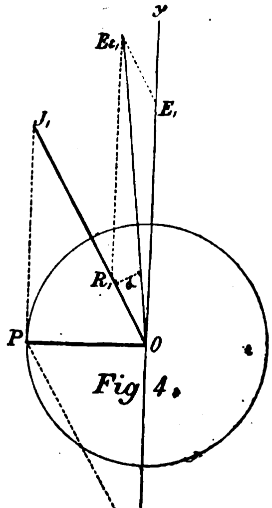
The problem now is to find what relations exist between these different waves as regards their relative positions and magnitudes. At first sight it may seem that this would prove a very difficult problem; and if an algebraic solution be attempted it is, in fact, if not very difficult, at least enormously complicated; but it is easy to treat the matter geometrically in a very simple way. As this method has already been published some time ago, it will not be necessary to demonstrate it, and I shall limit myself to a brief description, pointing out a modification of the original method by which the energy dissipated in magnetising the core can be taken into account. It will be seen from the above equations that F and E are proportional. Consequently, if we know what E.M.F. is to be put on the primary terminals of a given transformer, we also know with very close approximation what the induction and total flow of lines will be. If it were not for the slight disturbing influence of the resistance of the primary coil, we would know these data exactly. But the loss of E.M.F. by resistance can, for obvious reasons, only be trifling, and will in most cases be settled beforehand. We can therefore determine F with perfect accuracy, and from the constructive data of the core also the exciting power (τ I) which will produce this flow. It will be shown presently that it is inexpedient and uneconomical to work transformers with a high induction, and we may therefore regard the permeability to be constant for all points in the cycle. In this case τ I and F must at all times be proportional. Let, in Fig. 4, the circle represent the effective exciting power which we assume to coincide with the magnetisation, so that the projection on the vertical of the radius O P as it revolves (clockwise) round O represents the effective exciting power in ampere-turns, and, to a different scale, also the flow of force at any instant. The line representing the current in the secondary must evidently lag behind O P by a quarter cycle, and can be calculated from the formula for E_2, and from the resistance of this circuit. This gives us O I_2, the maximum exciting power due to the secondary coil alone. By erecting a vertical on O P in P, and making P I_1 = O I_2, we find the line O I_1, which represents in position and magnitude the maximum exciting power due to the primary coil alone. This gives us also the primary current, and we can now determine the loss of electromotive force due to the resistance of the primary coil. Let O R_1 represent this in direction and magnitude. The counter electromotive force in the primary must evidently be in advance by a quarter period over the magnetisation; that is to say, it must be represented by a certain length on the line O Y. Its amount can be calculated from the formula for E_1. Let O E_1 represent it to the same scale as was used for O R_1; then the parallelogram O R_1 E_{t1} E_1 gives us at once the point E_{t1} and line O E_{t1}, which represents in position and magnitude the maximum electromotive force impressed on the terminals of the primary coil, and α is the angle of lag of current behind impressed E.M.F. The work done on the primary coil is found by the well-known formula

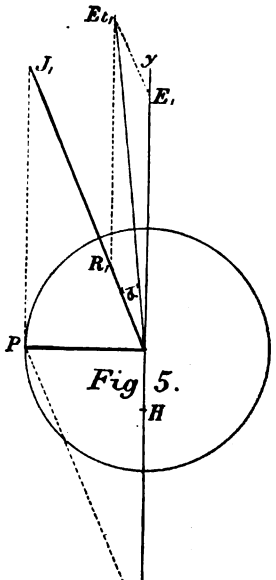
$$W_1 = \frac{I_1 E_{t1}}{2} \cos \alpha ;$$

$$W_1 = i_1 \, e_{t1} \cos \alpha .$$

That is to say, the true work is equal to the product of the apparent work, as measured by a dynamometer and voltmeter, and the cosine of the angle of lag. If the apparatus were supplied with current and at a constant and unidirected E.M.F. the apparent and the true work would be equal, and the ratio $\frac{1}{\cos \alpha}$ indicates how much larger must be the capacity of an alternate-current plant to do the same true work as a continuous-current plant. I propose, therefore, to call cos α the "plant efficiency" of the tranformer.

It was stated above that transformers should be worked at a comparatively low induction. This might seem at first sight a retrograde step, since with dynamo machines considerable gain in efficiency and output has resulted from adopting an induction up to 20,000 and more; but by reference to Fig. 4 one of the reasons why a low induction is preferable will be at once apparent. Suppose that the line O P represents the limit to which the induction may be pushed without diminishing the permeability; then, if the same transformer be worked at double the electromotive force, we would require an exciting power not only twice, but many times, as great as previously. This would bring the point P considerably to the left without increasing the length of line P I_1. It would also increase the length of the line O I_1—that is, the primary current—and therefore the heat generated in the primary coil, whilst the angle of lag would become greater and the plant efficiency smaller. Similar results would follow from an increase in the magnetic resistance of the core, or from the omission of a core altogether. An early type of transformer made by Messrs. Gaulard and Gibbs had no iron core, and therefore no well-defined magnetic circuit; but as the primary spirals alternated with the secondary spirals our previous assumption regarding the coefficient of mutual induction remains valid, and the above formulæ and graphic method could be applied to this apparatus if we knew what value to assume for the resistance of the magnetic-field. This, however, we do not know; but the case is of no importance at present, as transformers without iron cores have become obsolete. I only mention this early apparatus because the experimental investigations of Dr. Hopkinson and Prof. Ferraris* have proved that there is a considerable difference between the apparent and the true work; that is to say, the point P must have been a considerable distance to the left, making the plant efficiency small. In modern transformers the point P lies so close to O that the plant efficiency may reach as high as 99 per cent., so that the difference between real and apparent work supplied to the apparatus when giving full output becomes trifling; and for a practical determination of efficiency the readings of measuring instruments on the primary and secondary circuit may be used, with only such corrections as may be applied from the diagram.





A high plant efficiency is, however, not the only reason why transformers should be worked at a low induction. A far more important reason is the heating which takes place in the iron of the core if this be carried rapidly through cycles of intense magnetisation. This heating is not due to eddy currents (although these currents in a badly designed core would produce the

* "Ricerche Theoriche e Sperimentali sul Generatore Secondario Gaulard e Gibbs," by Galileo Ferraris. Turin, 1885.

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same effect), but seems to be the result of what may be termed dissipation of energy by molecular friction or hysteresis. The energy dissipated per cycle per cubic centimetre increases in more than simple ratio with the induction, and it seems also to increase as the periodic time decreases. As yet very few experiments have been made to determine the hysteresis for different samples of iron, the most important data published being those given by Prof. Ewing and Dr. Hopkinson in the *Philosophical Transactions*, Part II., 1885. Prof. Ewing distinguishes between static hysteresis (slow period) and viscous hysteresis (quick period), but the experimental data refer only to the former. According to Dr. Hopkinson, the energy required to carry one cubic centimetre of annealed wrought iron through a complete cycle of induction equal to 18,251 lines is 13,356 ergs., and for hardened tungsten steel with an induction of 14,480 lines the energy reaches 216,864 ergs. Prof. Ewing found that with very soft annealed wrought iron and $B = 13,190$ the energy dissipated by hysteresis was 9,300 ergs. He also tested annealed iron wire by carrying it through lower cycles; and, as the results are of very great importance in the construction of transformers they are given herewith:—

Induction.	Energy.
1,974	410
3,830	1,160
5,950	2,190
7,180	2,940
8,790	3,990
10,590	5,560
11,480	6,160
11,960	6,590
13,700	8,690
15,560	10,040

These figures refer to static hysteresis. As regards viscous hysteresis, no experiments have been made; but in the case of $B = 8,500$ and $n = 80$ Prof. Ewing estimates the energy dissipated per cycle at 5,000 ergs., or 32 per cent. above that of static hysteresis. When applying the figures of the table to transformers it may therefore (until further experiments have been made) be advisable to add from 30 to 40 per cent. to the energy there given. Thus, if an induction of 18,000 be adopted, the energy dissipated would amount to 18,000 ergs. per cubic centimetre per cycle; and with 80 cycles per second this corresponds to ·144 watt per cubic centimetre of core. It would evidently be extremely difficult, if not altogether impossible, to provide cooling surface enough for this rapid generation of heat, and hence it is necessary to work at a lower induction, the exact amount to be determined for each transformer by the cooling surface of the core and coils, and by the heat generated in the coils themselves. So far, then, theory points to the necessity of low induction. As regards practice, I believe the makers of transformers have already found out that it does not pay to press the iron magnetically too hard. My own experience was at least in this direction. In the first transformer which I designed jointly with Mr. W. H. Snell, and which is on the table, we worked at an induction of 20,000, and there were produced two very undesirable results. In the first place, the core heated to such a degree that continuous work was out of the question; and, in the second place, the apparatus emitted a most unmusical sound, and it was evident that on this account alone it was not fit for practical use. The sound may have been partly due to the employment of wood for the framework, but we believed that the high induction was principally the cause, and by dropping the E.M.F. so as to get an induction of 15,000 we found that these evils were lessened. We then constructed another transformer, in which the induction was reduced to 10,000. This transformer is also on the table. In it the sound was suppressed, but the temperature still rose by about 30deg. C. when continuously at work. We have, therefore, in a later design adopted a still lower induction. Although it is possible to reduce in this manner the amount of energy dissipated in the core, this waste cannot be entirely prevented, and must therefore be taken into account when determining by the aid of the diagram the working conditions of the apparatus. For this purpose it would, strictly speaking, be necessary to know, in addition to the total energy dissipated per complete cycle, also the rate of dissipation at each point of the cycle—a knowledge which we do not possess. It seems, however, reasonable to assume that the rate of dissipation of energy by hysteresis follows the same law as the rate of dissipation of energy due to eddy currents—that is to say, that it is proportional to the rate of change of induction. When the induction passes through zero the rate at which heat is generated would be a maximum, and this would gradually diminish to zero as the induction approaches its positive or negative maximum. On this assumption we can imagine eddy currents substituted for hysteresis; and in an iron core perfectly devoid of the latter property—that is, infinitely soft—the same amount of heating could be produced by imperfect subdivision, or, better still, by subdividing it perfectly, but wrapping round it a closed conductor of such a resistance that the heat generated in this conductor equals that dissipated by hysteresis in ordinary iron. For the ordinary transformer consisting of a perfectly subdivided core of iron not infinitely soft and a primary and secondary coil, we would substitute an imaginary transformer consisting of a perfectly subdivided core of iron free from hysteresis, a primary coil, a secondary coil, and a third closed coil of suitable resistance. The current in this third coil would coincide with that in the secondary coil, and its exciting power would be added to that of the secondary coil. For example, let the volume of iron affected by hysteresis in a particular transformer be 1,000 cubic centimetres, and let the energy of hysteresis be 5,000 ergs.; the total energy dissipated would, with 80 cycles per second, amount to 40 watts. If the electromotive force produced in the secondary coil be 100 volts, then our imaginary third coil would have either the same number of turns as the secondary coil and a resistance of 250 ohms, or it might have half the number of turns and a resistance of 62·5 ohms, or any other combination giving the same loss of energy. The mean value of the fictitious exciting power would in all cases be the same, namely, the number of turns in the secondary coil multiplied by ·4 ampere. Let, in Fig. 5, O H represent the maximum value of this exciting power due to hysteresis; then the total exciting power tending to demagnetise the core, and which must in a certain measure be balanced by the exciting power of the primary coil, is represented by the length of O I—being the sum of O H and HI_2, where HI_2 equals OI_2 of Fig. 4—and the point I_1 will be pushed higher up as compared with Fig. 4. The net result of this alteration is an increase in the amount of energy which must be supplied to the primary coil. It is thus possible to nclude the effect of hysteresis in the geometrical method of representing the working conditions of a transformer. I have dwelt at some length on this question, because, notwithstanding its apparently somewhat abstruse character, it is really of very great practical importance. In some transformers the heat generated in the iron core is in excess of that generated in the copper coils, even at full output. Now, where transformers are placed in parallel between high-potential mains, it is, for obvious reasons of safety, not advisable to allow customers to handle a switch on the primary circuit, and the current must therefore be on, whether lamps are being lighted from the secondary or not. When the supply is continuous, as it obvioulv must be in a general system, the cyclic changes of magnetism in the core of every transformer will be kept up day and night; and the question of heating becomes of far greater importance than is the case in dynamo machines, which, as a rule, are only worked for a certain number of hours per day.

On the basis of the foregoing we can now investigate the relative merits of the Gramme and Zipernowski rings, and the best proportion of copper to iron in each. I have selected the two original types and one modification of each as being fair representatives of the two large classes into which in the beginning of this paper I have divided all transformers. These "rings" are both equally difficult to manufacture, and contain serious practical defects; but from a purely electrical point of view they are probably as good as the majority of transformers now in the market. Their practical defects constitute for my purpose a posi-

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tive advantage, because nobody will care to claim either as his special type, and I shall thus escape the somewhat invidious task of having to compare the actual transformers made by rival manufacturers. As it is obviously impossible to conduct an investigation of this kind on absolutely general lines, it was necessary to assume rings of definite dimensions. I have selected rings of circular section having an internal diameter of 20 cm., and an external diameter of 42 cm., shown in full size in the wall diagrams (Figs. 2 and 3). The mean primary potential is assumed to be 2,000 volts, and the secondary 100 volts. The copper coils in Fig. 2, and the coils forming the iron shell in Fig. 3 are supposed to touch each other on the inside, and being of equal

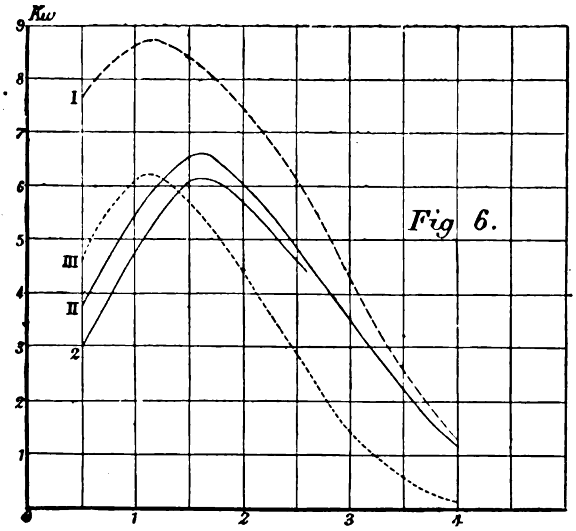

Fig 6.

depth all round, to separate on the outside, exposing part of the inner ring. In the Zipernowski transformer as actually made the inner diameter of the ring is rather smaller than shown in Fig. 3, and the shell winding covers the whole surface of the

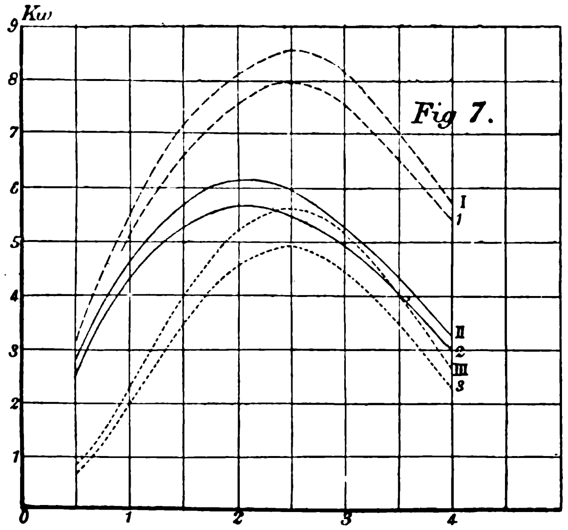

Fig 7.

conductor, being of less depth on the outside than on the inside; but the magnetic resistance is in either case so low that the difference between the assumed and actual arrangement does not materially affect the result, whilst the calculations for the former are somewhat less complicated. The total space occupied by insulation I have assumed to be 1 cm., or 2·5 mm. between the core of the Gramme ring and the primary coil, and 2·5 mm. between that and the secondary coil. The same space has been allowed for the Zipernowski ring. We can now assume different sectional diameters for the inner ring (core or coils), and depth of winding for the covering (coils or shell), so as to make up the 11cm. sectional diameter of the whole ring; and determine the output for each combination so that for continuous work the apparatus should keep moderately cool. From analogy with dynamos I estimate the total energy which may be wasted without producing overheating at 260 watts; and the output has in all cases been calculated on this basis for an induction of 8,500, a periodic time of $\frac{1}{80}$ second, and hysteresis at 5,000 ergs. As it would serve no useful purpose to burden this paper with a reproduction of the somewhat lengthy calculations, I have plotted the results in the curves II. (Figs. 6 and 7). The curves I. show the output which might be obtained if hyteresis did not exist, in which case the whole of the 260 watts would be transformed into heat within the coils. The thickness of copper winding (Fig. 6), and that of the iron shell (Fig. 7), is plotted on the horizontal, the output on the vertical. From Fig. 6 it will be seen that the maximum output with the Gramme ring is 6,400 watts with a thickness of copper winding of about 1·7 cm., leaving 6·6 cm. for the sectional diameter of the core. The cross-sectional area of the magnetic circuit is in this case about 80 per cent. of the cross-sectional area of the electric circuit, and the gross volume occupied by iron is about equal to the gross volume occupied by copper. The maximum output for the Zipernowski ring (Fig. 7) is 6,100 watts for an iron shell 2cm. thick, leaving the sectional diameter of the coils 6cm. The cross-sectional area of the magnetic circuit is in this case nearly eight times that of the electric circuit, and the gross volume occupied by iron is $1\frac{1}{4}$ times that occupied by copper. Thus, with the same external dimensions, the Zipernowski ring gives a slightly lower output than the Gramme ring; but it must be remembered that the weight of copper is also slightly smaller. I have made the same calculations for oblong rings, as shown in Fig. 8. Imagine the

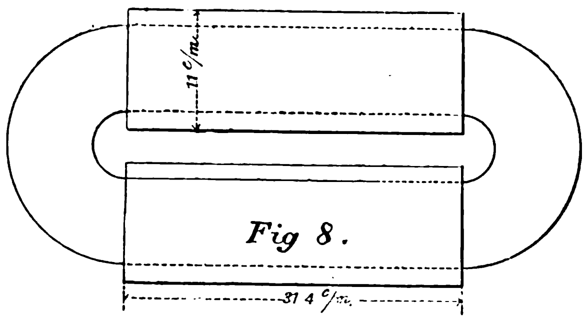

Fig 8.

Gramme ring cut in halves, these straightened and laid side by side, and the two cores joined by semi-circular pieces at the ends. The copper coils will in this process not be altered, but the length of the magnetic circuit and the volume of iron in the core will be increased; hence more energy will be absorbed in hysteresis, and the output will be reduced. In Fig. 6 the curve 2 represents the output for the oblong Gramme ring. By adopting the oblong shape for the Zipernowski ring we do not alter the mass of iron in the shell, but we lengthen the electric circuit, and increase the waste of energy in the coils. In this case also the curve of output 2 (Fig. 7) must lie below that of the circular type. Curve 1 (Fig. 7) shows the output of the oblong type if there were no hysteresis. In Fig. 6 this must obviously coincide with curve I. The maximum output of the oblong type is—For the Gramme ring a little over 6,000 watts; and for the Zipernowski ring 5,800 watts.

Up to the present we have only considered the output as limited by the amount of energy which may be wasted without overheating. But there is another and equally important consideration which affects the output, namely, the question of self-regulation. It is evident that in a transformer fed at a constant potential the induction is a maximum when the secondary circuit is open; for in this case the counter electromotive force of the primary is very nearly equal to the electromotive force at the terminals. At full work the two differ by the amount lost in resistance, and the induction is reduced in the same proportion. The electromotive force generated in the secondary coil is proportional to the induction, and we must deduct from it the loss in resistance in order to obtain the external electromotive force. Thus, if 1 per cent.

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be lost by resistance in the secondary, and 1 per cent. by resistance in the primary, the difference of available electromotive force between open circuit and full output will be 2 per cent. For good lighting this may be considered the permissible limit of variation, and on this basis I have calculated the output of the four transformers above described. Curve III. in Fig. 6 gives the result for the circular and oblong Gramme ring. It will be seen that with a stout core the limit of output due to heating is reached sooner than that imposed by the condition of self-regulation, whilst for thin cores the reverse is the case. The best proportion of iron to copper is indicated by the intersection of curves III. and II. for the circular, and III. and 2 for the oblong transformer. In the latter case the core would have to be 7·2cm. in diameter, and the winding would have to be 1 4cm. deep. The output is 5,900 watts. For the Zipernowski ring curve III. gives the output as limited by self-regulation in the circular, and curve 3 in the oblong type. The diagram shows that the limit of output imposed by the condition of self-regulation is in all cases reached sooner than that due to heating. For the oblong transformer the maximum output is slightly below 5,000 watts, and the best proportion of iron to copper is given by the abscissæ of the highest point of curve 3. The external shell would have to be 2·4cm. thick, and the sectional diameter of the coils 5·2cm. From the above figures it appears that in the circular and in the oblong type the Gramme ring, dimensioned as shown in Figs. 2 and 8, gives more output than a Zipernowski ring of the same over all dimensions; the latter is therefore not superior to the Gramme ring, as commonly supposed, but somewhat inferior.

It might be, perhaps, objected that I have selected proportions different from those found in actual circular shell transformers, which have a much stouter ring of smaller mean diameter. More of the internal space is filled by the shell, and the central hole left is much smaller than shown in Fig. 3. The iron wire forming the shell is not put on in regular layers, but the turns cross each other in a more or less confused manner. There is no objection to such winding from an electrical point of view, as perfect insulation between the wires is of small importance. For the Gramme ring such winding would, on the other hand, be quite inadmissible; and it is on this account that I have selected a somewhat larger internal diameter of the rings, which gives room for regularly wound coils. But even if the rings are much stouter their proportion of output is not materially altered. If we imagine the ring of Fig. 3 contracted so as to reduce the central opening to 10cm. and the extreme diameter to 32cm., we obtain about the proportion of a Zipernowski transformer.

For convenience of calculation I have assumed a ring of these proportions to be changed into the oblong type, as shown in Fig. 8, but with this difference—that the external winding (coils or shell) on each side is only 15·7cm. long instead of 31·4 cm.; the diameter being 11cm., as before. Calculating the output in the same manner as before, I find that for the core transformer the maximum output as limited by heating is 3,230 watts, and is reached when the copper winding is 2cm. deep; whilst the maximum output as limited by the condition of self-regulation (within 2 per cent.) is 3,020 watts, and corresponds to coils wound 1cm. deep. The two curves cross each other as in Fig. 6, and the ordinate of the crossing point corresponds to a maximum possible output, as determined by the joint limit of heating and self-regulation, of 2,950 watts with coils wound 1·3cm. deep. In the shell transformer the limit of output due to heating is 3,030 watts when the shell is 2cm. thick, and the limit of output due to self-regulation is 1,650 watts when the shell is 2 2cm. thick. These figures show that even in stout rings, having proportions more nearly comparable with those of the Zipernowski transformer as actually constructed, the core type is better than the shell type.

This result refers, however, only to transformers having a core or a shell of circular section; and the question is whether by an alteration in the form of the shell the shell transformer could be improved. Any departure from the circular form of the shell must increase the length of the magnetic circuit, and must so far be detrimental; but if we can at the same time reduce the length of the copper coils, this disadvantage may be more than balanced by the reduction in the resistance of the circuits. As a matter of fact, the magnetic resistance of the shell is so low that even a considerable increase in the length of the magnetic circuit does not materially affect the difference of phase between the primary and secondary current. The two are almost diametrically opposed whatever may be the magnetic resistance. We can therefore adopt any shape of shell which will allow the length of the copper coils to be reduced. This is actually done in most modern transformers. The shell is rectangular, with the short side of the rectangle parallel to the plane of the coils, and thus the mean diameter of the coils is reduced. In addition to this the circular form of coils has been abandoned in several of the more modern transformers, so that the shell may fill more or less completely the interior of the coils.

In core transformers as now generally made the coils are not arranged all over the core, but are disposed in two sets, one on each limb of a single core. Each set of coils contains a primary and secondary circuit wound upon each other, or one between the other, so as to obtain perfect symmetry. Were this not so, and were one limb wound with the primary and the other with the secondary, external poles would be formed at opposite points of the core, and the output would be reduced. In a similar manner the coils in shell transformers are wound upon or in between each other, but there is generally only one set of coils and a double core. The distinctive characteristics of the two types are therefore as follows:—

Core transformers—One core and two sets of coils.

Shell transformers—Two cores and one set of coils.

The following are some of the principal modifications of each type:—

Core transformers—Gaulard and Gibbs, Lowrie-Hall.

Shell transformers—Zipernowski, Ferranti, Mordey, Wright, Kennedy, Statter, Westinghouse, Snell and Kapp, Gaulard and Gibbs.

As most of these transformers are on the table, I need not describe them at length. The original Gaulard and Gibbs transformers had an open magnetic circuit, and cores which could be more or less inserted into the coils so as to regulate the E.M.F. of the secondary—a provision obviously necessary where the transformers are coupled in series. In the apparatus shown in 1883 at the exhibition in the Aquarium, there were four distinct induction coils; and in that employed for lighting on the Metropolitan Railway in 1884 there were sixteen distinct induction coils, the circuits being formed by a compound cable consisting of a central primary wire and six secondary wires grouped round it. In 1885 was introduced a type of transformer with closed magnetic circuit, in principle identical with that shown in Fig. 8, but the two limbs further apart. In the same year Messrs. Gaulard and Gibbs introduced small shell transformers in their Tivoli installation, each transformer feeding one 50 candle-power lamp. The two circuits are formed by a compound cable coiled into a solenoid, through which is passed a bundle of iron wires; the projecting ends are then bent over to close the magnetic circuit on the outside of the solenoid, and the whole is encased in a perforated metal cylinder with wooden ends. In their latest design of transformer the coils are circular in plan and rectangular in section, and are surrounded by groups of U-shaped soft iron stampings slipped over from both sides and held together by two circular cast-iron plates with a central bolt. The primary circuit is split up into two coils, with the secondary between them.

In the Lowrie-Hall transformer there are two sets of primary and secondary coils, laid horizontally one above the other. The core is formed by thin broad sheets of soft iron insulated from each other by varnished calico, and the projecting ends of these plates are alternately bent up and down respectively so as to complete the magnetic circuit, the whole being clamped together in a horizontal cast-iron frame. The Ferranti transformer is similar in the mechanical arrangement, but, belonging to the shell type, has only one set of coils of rectangular section. The core is formed of thin iron strips of moderate

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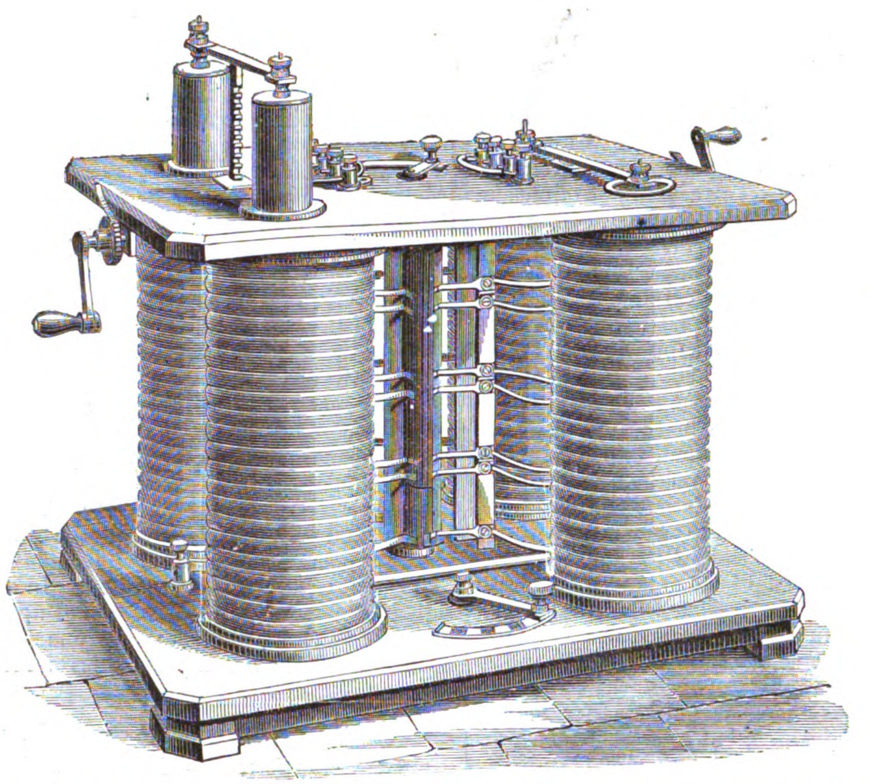
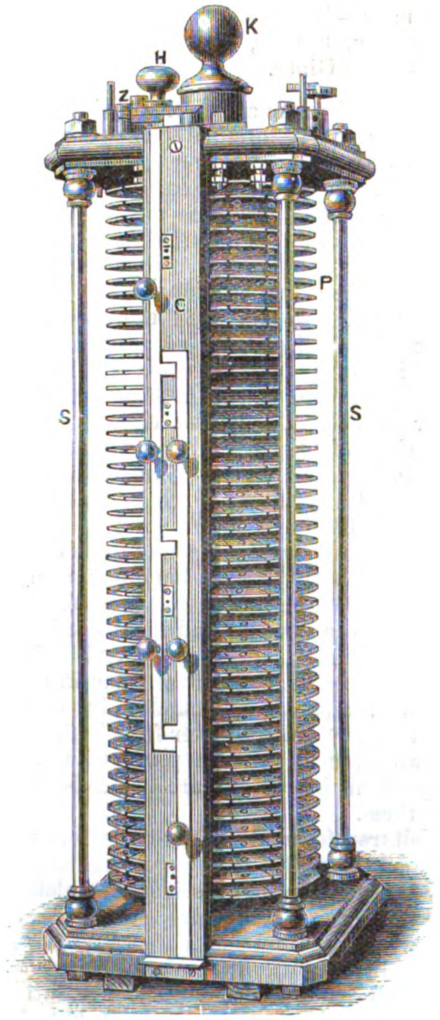
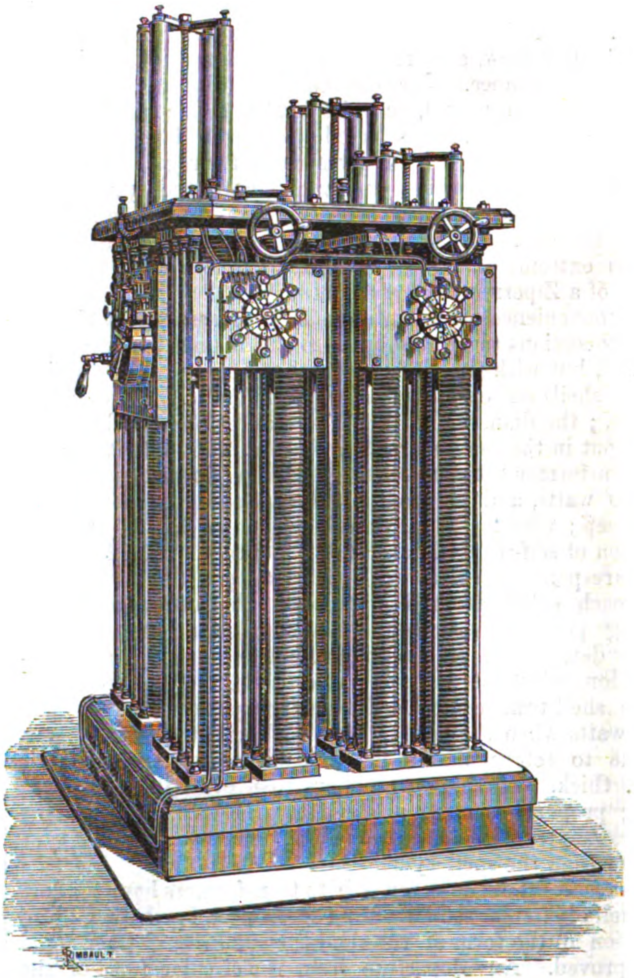


GAULAUD-GIBBS TRANSFORMER: type used at the Aquarium in 1883. Open Magnetic Circuits, Adjustable Cores, Primary Coils in Series.



GAULAUD-GIBBS TRANSFORMER; type first used at Turin in 1884. Open Magnetic Circuit, Copper Disc Coils.



GAULAUD GIBBS TRANSFORMER; type used on Metropolitan Railway in 1884. Open Magnetic Circuit, Adjustable Cores, Primary Coils in Series.

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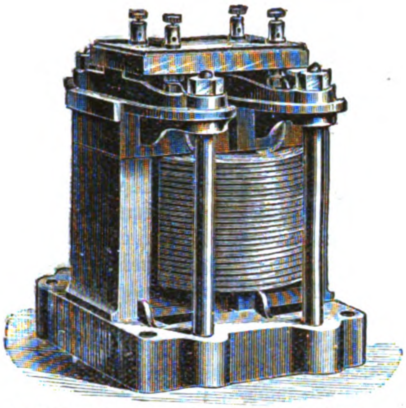
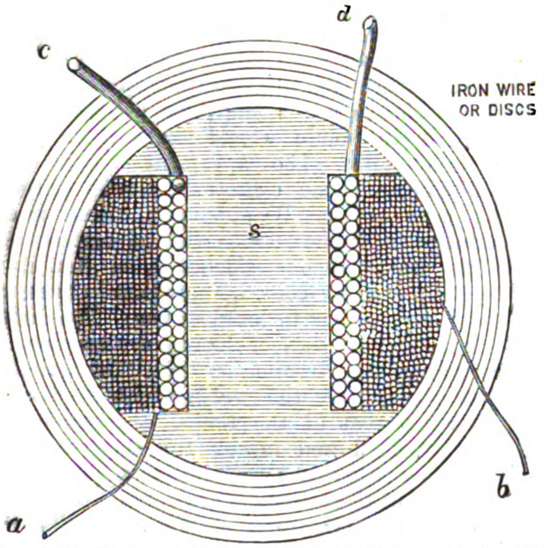
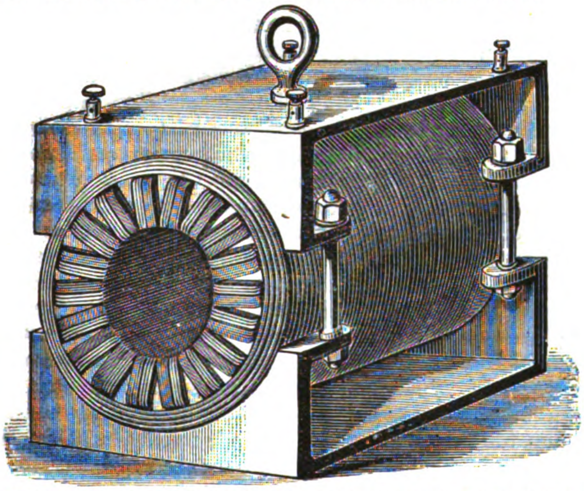


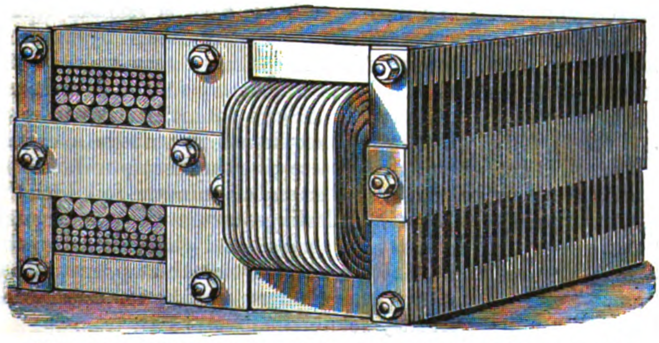
THE KAPP AND SNELL TRANSFORMER.



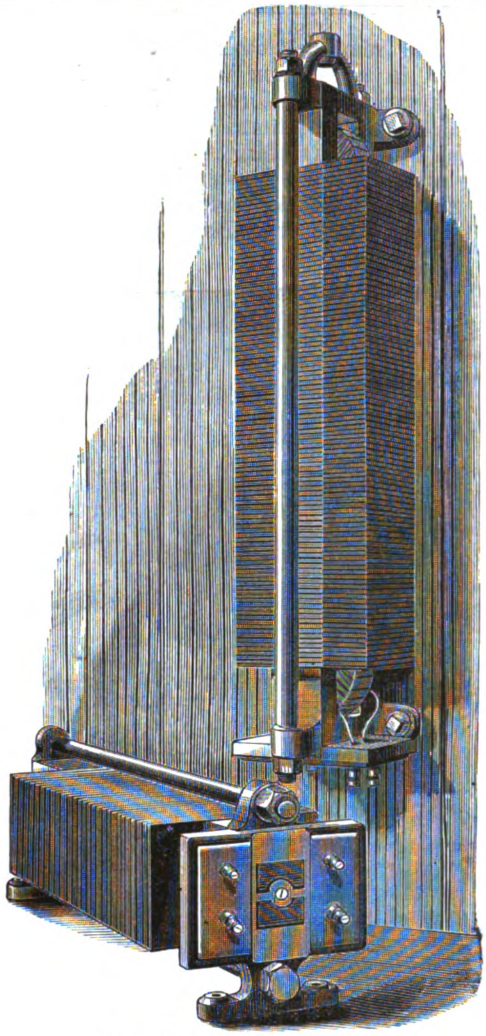
KENNEDY TRANSFORMER (1885), consisting of a Siemens shuttle-wound armature with laminated core *s*, and double winding. *a*, *b*, fine wire; *c*, *d*, thick wire. The whole is surrounded with a sheathing of fine wire or discs.



KENNEDY'S "SUBDIVIDED" TRANSFORMER, consisting of a Paccinotti ring, in which each section is wound both with a primary and secondary coil. An outer sheathing of iron wire is wound on.



KENNEDY TRANSFORMER, used for raising potential in the mains at the generating station.



THE MORDEY TRANSFORMER.

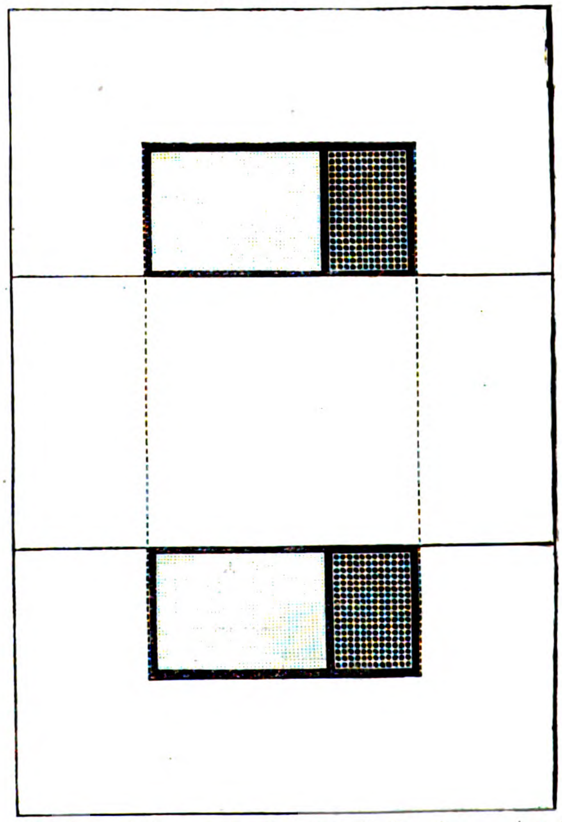


Diagram showing method of construction of Mordey Transformer. A rectangular piece (shown by dotted lines) is stamped out of the centre of a piece of hoop iron, and is laid across at right angles to the aperture (as shown by the two horizontal lines in the centre). This leaves two open spaces (shown by dark lines), through which the primary and secondary coils pass. The coils are wound on a former, and the transformer is built up by alternately slipping the outer iron pieces *over* the wires, and threading the cross pieces through.

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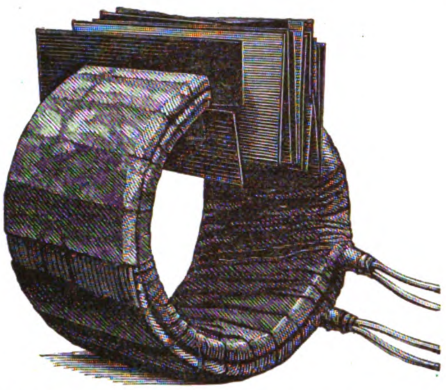
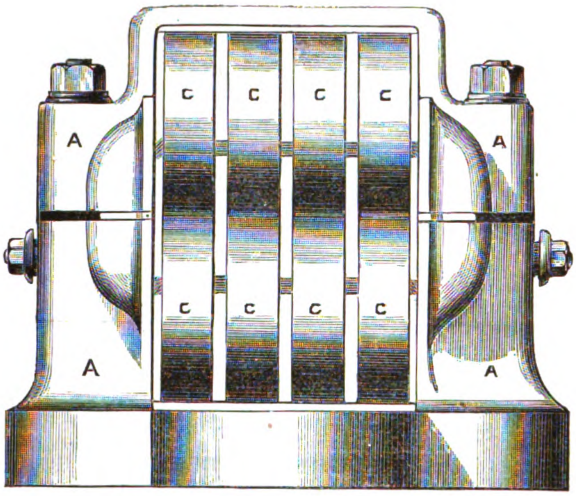
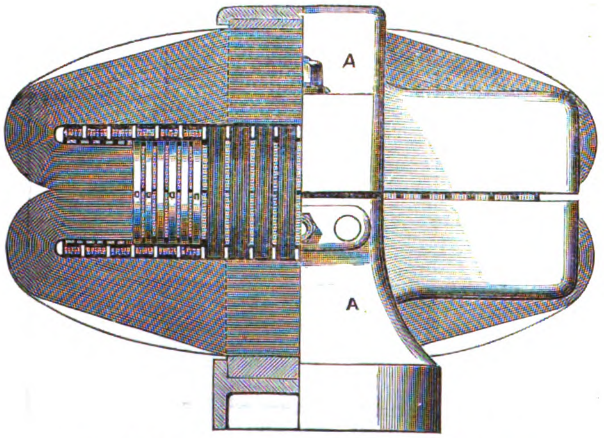
width insulated from each other, doubled over at the ends, and clamped in a cast-iron frame. Mr. Rankin Kennedy has devised various transformers of the shell type. For the general supply of alternating-currents he proposes to use a main current transformer at the generating station, in which currents from low-tension dynamos are to be converted into high-tension currents to be sent into the mains. The shell of this transformer is built up of moderately



WRIGHT'S "BRIGHTON" TRANSFORMER in process of man cture; showing method of slipping plates over coils.



Th ERRANTI TRANSFORMER. Showing bundles of hoop iron C C and casing A A.



The FERRANTI RANSFORMER. Half sectional view

wide but very thin strips, to form a rectangular frame of considerable depth, the strips being fastened by bolts at the corners. The core is composed of a series of strips of double width passing like a web through the middle of the opening of the rectangle, and thus subdividing it into two openings through which the winding passes. In another type, which Mr. Kennedy calls the "Piled Form of Subdivided Transformer," the iron portion consists of H stampings, in which the central web forms the core and the two down strokes of the H the shell, the coils being wound over the web. A number of these wound frames are piled upon each other, and side by side, the whole being clamped between cast-iron covers. Diagrammatically, this construction can be represented by Fig. 1 if instead of employing only two links we use a number of them formed into a chain consisting alternately of copper and iron circuits. In another form of apparatus Mr. Kennedy uses a Siemens shuttle armature overwound with a shell of iron wire. Mr. Wright's transformer may be described as a Zipernowski ring with coils of rectangular section and a shell of rectangular iron frames instead of the original iron winding. Each frame is cut across a corner, so that it may be placed over the core; and as the edges are packed close on the inside, but radiate on the outside of the ring, the frames form gills for the dissipation of heat. In Mr. Mordey's transformer the shell consists of thin rectangular iron plates with a rectangular opening, the strip cut out being laid across the frame to form the core of the coils. The ratio in the length of the sides of the rectangle must evidently be as 4 : 6, and that of the strip cut as 2 : 4, in order to obtain a uniform section throughout the magnetic circuit. The apparatus is built up by alternately slipping a frame over and a strip through the coil. The core of the Westinghouse transformer consists of rectangular frames, each with a central web connected to the frame on one side only, so that it can be bent back to slip over the coils. The whole is mounted in a cast-iron weather-proof box for outdoor use. The shell in Mr. Statter's transformer consists of E-shaped stampings slipped over the coils alternately from either side. To obtain the same area of iron throughout, the width at the bottom of the stamping is twice that of the limbs. In the transformer designed by Mr. Snell and myself the shell consists of U stampings forming a double trough into which the coils are laid. The covers of these troughs are formed from the metal removed from the interior of the stampings. The whole is held together in a cast-iron frame so arranged as to allow air to circulate through the core and round the coils.

To render transformers perfectly safe it is necessary to avoid leakage between the two coils. For this purpose Mr. Kent has devised a very simple apparatus, consisting of an insulated sheet of metal wrapped round the inner of the two coils, but not forming a closed circuit in itself. This sheet of metal, which thus separates the two coils completely, is connected to earth. Now, if the insulation of the primary coil should fail, the leak, before reaching the secondary coil, must pass through the sheet of metal, and is thus conducted to earth, causing the primary cut-out to melt, and thus cutting the faulty transformer out of circuit. Another safety appliance has been devised by Captain Cardew. Its object is to disconnect the primary circuit from the mains if any part of the secondary circuit acquires a certain potential above that of the earth, which will take place if a leak occurs between the two circuits. The apparatus consists of a cast-iron box on the bottom of which is laid, into a shallow recess, a strip of platinum foil terminating at both ends in circular discs. About one-eighth of an inch clear above one of these discs is set a metal disc with screwed stem at the back passing through the glass cover of the box, and connected by a fine fuse wire with any point of the secondary circuit. The box itself is connected to earth. The fuse wire holds back a contact spring so arranged that on breaking of the wire it will fly down to its contact and short-circuit the primary terminals of the transformer, after which its own primary fuse will melt and cut off the supply of current. If the potential between earth and the insulated disc in the box should rise above a certain limit (which can be regulated by screwing the disc up or down) the static attraction between the disc and aluminium foil lifts the latter into contact, allowing a leakage current to pass through the fuse wire of the contact spring, and thus releasing the latter. I am told by Captain Cardew that this apparatus has been tried at the Grosvenor Gallery installation, and been found to act in a perfectly reliable manner.

In the present paper I have only dealt with what may be called elementary principles in the construction of transformers.

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As, however, the application of transformers is a matter of far greater importance to our profession at large, I trust you will allow me to say a few words on this subject, not with the object of imparting information, but in the hope that a discussion of real practical value may be the result. Up to the present, distribution by transformers has been made either on the single series or the single parallel system; compound parallel, the three-wire system, or any other refinement of direct supply methods, have, to my knowledge, never been attempted with transformers. The series system must fail for want of self-regulation where the lamps are to be connected in parallel and controlled independently of each other; but for very extensive and sparsely lighted districts, with the lamps supplied by each transformer in series on the Bernstein system, a series arrangement of transformers will admit of perfect self-regulation, provided the primary current be kept constant, and will, moreover, be cheaper than the parallel system. For general purposes, and especially for the dense lighting required in towns, the only practical method at present in use is to connect the primary terminals of the transformers all in parallel, and the lamps also in parallel, across the secondary circuit of each transformer. In principle this arrangement is adopted in England, America, and on the Continent; but the methods differ in these countries. Here the distribution is made by a high-tension network of mains, and the transformer of each subscriber is directly connected with the mains. In America a double network of overhead mains is employed, one for the high-tension and the other for the low-tension currents. These mains are supported generally on the same poles, to which are also fixed the transformers, and the subscriber's connection is made with the low-tension mains wherever convenient. On the Continent a network of low-tension underground mains is used for distribution in the same way as if the supply were on the direct system, and this network is fed by alternating currents at certain points where fairly large transformers are installed. The primaries are connected with the station either by overhead wires or by a special kind of cable containing two circuits insulated from each other and arranged concentrically. The cable is protected by a double lead covering and by an iron sheath formed of spirally-wound tape. Of the three methods here described our own appears to be the worst, the American slightly better, and the Continental the best. To string high-tension wires over and across our streets, allow high-tension branch leads to pass into our houses, and give every subscriber a little transformer to himself, more or less within the reach of the inmates, seems to me to be positively courting disaster. Such rough-and-ready methods may do as long as the light is not generally installed throughout a district; but once assume that every householder is using it (and it is that we are hoping for), the thousands of branch wires and transformers in the houses must constitute a very serious element of danger. In the American plan the high-tension wires are not brought into the houses, and in so far there is little danger to the inmates; but of course in the streets there is the same danger as here from the overhead wires.

Now, the Continental plan may almost be called absolutely safe. With an arrangement like Mr. Kent's dividing sheet to prevent leakage, or Captain Cardew's ingenious apparatus for detecting it and cutting off the supply, the secondary circuit can never acquire a potential sufficiently high to endanger life or property. This network can be composed of comparatively light cables, because we can feed it at frequent intervals and thus insure constancy of pressure at all places and at all hours. The transformers would be fairly large—say from 500 to 1,000 lights each—and could be installed in rooms to which no person but the authorised attendant has access; and by placing the primary feeding mains also underground accidents would be rendered almost impossible. The method of using an underground secondary distributing network has also the advantage that, should at any future time storage batteries become sufficiently improved to render distribution by continuous currents possible, the whole of the cables would be available for this purpose without any change.

[We are indebted to Messrs. Gaulard-Gibbs, Mr. Rankin Kennedy, and Messrs. Sharp and Kent, for some of the blocks used in illustration of this paper.]

MEETINGS OF SCIENTIFIC SOCIETIES.

TO-NIGHT (FRIDAY), February 10th.

ROYAL INSTITUTION.

9 p.m. Discourse on "Safety Lamps in Collieries." By Mr. W. H. PREECE, F.R.S., M.R.I.

INSTITUTION OF CIVIL ENGINEERS.

7.30 p.m. Supplemental Meeting for Students. Paper, "Arched Ribs and Voussoir Arches." By Mr. H. MEDWAY MARTIN, Wh. Sc., Stud. Inst. C.E.

PHYSICAL SOCIETY OF GLASGOW UNIVERSITY.

"Apparatus for Determining the Horizontal Component of the Earth's Magnetism." By Mr. T. GRAY, B.Sc., &c.

SOCIETY OF ARTS.

8 p.m. Indian Section. "The Work of the Afghan Frontier Commission." By Captain MANIFOLD, R A. Mr. M. MACLEAN, M.P., will preside.

"Facts regarding the Religions of India, and their Influences on the Moral Progress of the People." By Sir WILLIAM W. HUNTER, K.C.S.I., C.I.E., LL.D.

SATURDAY, February 11th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Experimental Optics" (4). By Lord RAYLEIGH.

NATIONAL SMOKE ABATEMENT INSTITUTION (at the Society of Arts).

8 p.m. Lecture on "Town Smoke and House Warming." By Mr. A. E. FLETCHER, F.C.S.

MONDAY, February 13th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III. "Yeast, its Morphology and Culture." By Mr. A. GORDON SALOMON, F.C.S., F.I.C.

TUESDAY, February 14th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion, "The Economic Use of the Plane-Table in Topographical Surveying." By Mr. JOSIAH PIERCE, Jun., M.A., A.M.I.C.E.

SOCIETY OF ARTS.

8 p.m. Applied Art Section. "Principles of Design, as applied to Bookbinding." By Mr. HENRY B. WHEATLEY. Sir GEORGE BIRDWOOD, K.C.I.E., LL.D., M.D., will preside.

ROYAL INSTITUTION.

3 p.m. Lecture, "Before and After Darwin" (5). By Mr. G. J. ROMANES, M.A., &c.

ROYAL VICTORIA HALL (Waterloo Bridge-road, S.E.).

Lecture, "Earthquakes and Volcanoes." Illustrated by Dissolving Views. By Mr. EDWARD WETHERED. Chairman, Hon. and Rev. CANON PELHAM.

WEDNESDAY, February 15th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Type-Writers and Type-Writing." By Mr. JOHN HARRISON. Sir HENRY THOMPSON, F.R.C.S., will preside.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Meeting. The following Papers will be read:—"Electrical and Meteorological Observations on the Peak of Teneriffe." By the Hon. RALPH ABERCROMBY, F.R.Met.Soc. "Rainfall of South Africa, 1842-1886." By Mr. W. B. TRIPP, M.I.C.E., F.R.Met.Soc. "Some Methods of Cloud Measurements." By M. NILS EKHOLM.

ROYAL VICTORIA HALL (Waterloo-Bridge-road, S.E.).

Meeting of Employers and Working Men to discuss the best means of obtaining Technical Education. Chairman, Captain Sir DOUGLAS GALTON, K.C.B.

THURSDAY, February 16th.

CHEMICAL SOCIETY.

8 p.m. Meeting.

SOCIETY OF TELEGRAPH-ENGINEERS.

8 p.m. Students' Meeting. Mr. W. E. HAYNE will open a Discussion on Mr. Cockburn's Paper on "Safety Fuses, &c."

ROYAL SOCIETY.

4.30 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

3 p.m. Lecture, "Early Secular Choral Music" (2). By Prof. C. H. H. PARRY.

Sharp and Kent v. D'Humy.—In this case judgment was delivered yesterday for the plaintiff on all issues.

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PARLIAMENT AND THE ELECTRIC LIGHT.

It is to be hoped that among the English measures pledged for the Session of Parliament which opened yesterday a not inconspicuous place may be found for the Electric Lighting Act Amendment Bill. Last year a measure of relief, which, although not wholly satisfactory, was one that all parties were agreed to accept, had been safely carried through the House of Lords and received the support of the Government, but was dropped in the Lower Chamber, apparently owing to the impossibility of carrying through any useful reform not borne upon the crest of some prevailing political wave or supported by the wires of party machinery. This year, with its promise of an English session, we may reasonably demand a fair hearing in the Commons for the Bill of Lord THURLOW, or its equivalent, which will doubtless be reintroduced in the House of Lords; and we entirely endorse the words of Major FLOOD PAGE in *The Times* of the 31st ult., when he claims on the one hand the right of the public to have the electric light, and on the other the right of the electric lighting companies to supply it. These rights the Act of 1882 practically extinguished, and to reassert them is the object of the legislation we look forward to in the present year.

Our six years' experience of it has sufficiently demonstrated the prohibitory character of the original Act and the vitality of the industry which it was intended to regulate. As a matter of fact the legislation of 1882 has regulated nothing; but, on the other hand, it has not succeeded in extinguishing the electric light, which has been steadily making progress without any legislative help or regulation whatever. In some ways this is a matter for congratulation; but from the point of view of the framers of Mr. CHAMBERLAIN'S Act the supply ought to have ceased altogether if it dispensed with the rules and conditions imposed by the Legislature. The supply has not ceased; on the contrary, it has extended far beyond what in the circumstances could have been expected, and it has grown rapidly in public esteem. In other words, the public have exerted their right to use the new illuminant, and the companies their right to supply it outside the area of parliamentary restrictions. What is now desired is that the restrictions upon its use within that area shall be removed; and we make bold to say that neither on commercial nor politico-economical grounds can the rights thus established in one direction be justly withheld in respect to the other. Of course their exercise must be subject to municipal or even imperial regulations, such as are found to work well in the case of the gas and the water supply. But it is one

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thing to define conditions under which public works shall be carried out, quite another to frame them in the sole interests of the local authorities or existing competitors.

It has been recently stated that our demands have increased with every year's delay in amending the obstructive enactment. A fairer statement of the case would be that every year's experience has added fresh proofs that the Act was unworkable either in its original form or in that which the Government responsible for it afterwards agreed to recast it. So much capital was at first invested in the business, and such vast expectations were raised in respect to its capabilities, that terms were accepted, though with misgivings, that would now be rejected as utterly inadmissible. It is no reproach to the electric lighting undertakers to admit that their earlier calculations were too sanguine, and that their knowledge of the business now enables them to say that while ready to compete on equal terms with any rival in the field, they cannot hope to do so with satisfaction to the public or with profit to themselves on any such conditions as those enforced by the original Act, or suggested later on for their mitigation. To extend the period of concession, it was soon perceived, would not touch the main objection to its ultimate provision—namely, the compulsory purchase of the stock and plant at a valuation, the business, as a business, counting as of no value at all. So long as this extraordinary and unprecedented condition remains part of the law of the land as affecting this particular industry, so long will the parties pecuniarily interested in it increase their demands for a prolongation of the period of concession in order to cover, if possible, the loss by virtual confiscation when the concession expires. The legislation of 1882 was, in fact, a socialistic experiment which, in vulgar terms, might be called a try on. It has signally failed; and in the interests of sound economics, as well as in those of the electric lighting industry, the British public may be thankful that this ingenious essay in social plunder has been thoroughly discredited.

The two main alterations embodied in the amendments approved by the House of Lords last year were the extension of the concession period from twenty-one to forty-two years, and the substitution of compensation for confiscation. The enlargement of the period is a valuable improvement, giving greater stability to the business and a fairer prospect of adequate remuneration for the risks involved. As some of the leading companies are ready to accept this concession, we need offer no objections to their policy, supposing they are quite sure no better terms can be obtained. But obviously the Bill of Lord RAYLEIGH in 1886, placing the electric lighting business on exactly the same footing as that of water and gas, would be preferable. It seems to us that there is no need to define the period; and in the interests of the public, Parliament ought not to restrict its own future action in that hard and fast way. Parliament could at any time enact the compulsory purchase of any gas or water company in the kingdom, notwithstanding their nominal monopoly in perpetuity. So long as the terms of purchase are not prescribed in the first instance unfavourably for the expiry of their business, the companies need not trouble themselves about the date when their existence will terminate. It would be far better to define nothing whatever in respect to time or terms. It was the precise definition of both that constituted the new and mischievous departure of Mr. CHAMBERLAIN'S Act. If, however, in these days we must yield to the heretical tendencies of social legislation, the terms of purchase, if defined at all, must be our chief object of consideration. On this point electrical engineers should bring all their united energy and influence to bear, for on this will depend their power of raising capital to work under the amended Act. That they did not combine together in respect to the original Act was made pretty evident in Mr. T. H. BLAKESLEY'S able pamphlet, "Electricity at the Board of Trade," published soon after the Board had framed those regulations which, as every electrical engineer now knows perfectly well, were simply incapable of practical realisation. These gentlemen only combined to make identical requisitions for provisional orders which were never taken up, and which, perhaps, they never seriously intended to take up. Let them now unite for the more legitimate object of influencing the Legislature, and obtaining that relief to which the importance of their business and the wants of the public entitle them. Unless something unforeseen should occur, there is reasonable ground for hope that a satisfactory amendment of the Electric Lighting Act may be carried this Session if the parties most concerned are agreed as to what they urgently need and will cheerfully accept.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER VII.—*Simple Tests with Indicators (continued).*

(Continued from page 322.)

77. The manner of working out a simple insulation test with an indicator as above described will now be shown. It will be noticed that no mention has been made of the testing of the insulation resistance of a submarine cable by this means, since it requires a more delicate instrument to do this, not only on account of the far higher insulation resistances of cables for the same length, but also because it is necessary to watch their behaviour during a test, and therefore a delicately suspended needle which will detect minute changes is necessary. In addition to this there is a condenser-like action causing the resistance to increase during the connection of the testing battery. This effect observed in cables when one end is "free" and the other connected to a battery is known as "electrification," and will be considered further when the more delicate instruments applicable to cable tests have been examined. For the present test, however, we are considering overhead lines, such as bare telegraph wires with an insulation ranging from, say, half a megohm to 10 megohms per mile, according to the state of the weather, and long overhead covered main wires supplying lighting currents from a central station where an insulation of about one to two hundred thousand ohms per mile may be expected.

Suppose now, that a sensitive horizontal indicator is connected up to one end of an overhead line 10 miles long, and that the other end of the line has been carefully "freed." Before connecting up the battery the indicator must be "set" by turning it round till the pointer is at 0°; the needle is then parallel to the plane of the coils. While doing this everything in the immediate neighbourhood of the instrument likely to be magnetised and moved about must be removed altogether and placed at a distance where it cannot affect the needle, otherwise very discordant results may be obtained. Especially must pockets be ransacked of everything magnetised, as these approach very near the instrument when bending over to read the deflections. Anyone who is much in the company of dynamo machines has everything about him in the shape of steel magnetised. Some little time ago a letter appeared in one of the electrical papers from an electrician who had wasted a lot of time trying to find out what affected the needle of his testing instrument, and having discovered the cause of these erratic movements kindly gave others the necessary warning. After ransacking pockets and removing everything he considered magnetic, together with his umbrella, to a distance, he at last found that his hat contained something magnetic and was doing the mischief. This he did not discover by pulling the hat to pieces, but by politely taking it off before the instrument and moving it about near the needle, when the effect was evident. The circuit should now be com-

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pleted by connecting the remaining terminal of the instrument to a battery of, say, ten cells, and the other pole of this battery to earth, as shown in section 76, Fig. 36. If the deflection is larger than 45deg. the battery power should be reduced until it approaches that angle, but it is more probable that considerably less than this will be observed. The current now passing through the instrument is due to leakage from the line to earth, generally a uniform leakage at each post or support, and the exact resistance which this represents can be calculated by observing what deflection is produced by the same battery through the instrument and a *known* resistance. The calibration of indicators or the comparison between their deflections and the currents producing those deflections not having yet been explained, it is not supposed that we know whether the instrument reads proportionally to the current or not, in which case the known resistance would be one that could be adjusted to any amount, and this would be varied until the instrument showed the same deflection as was observed when in connection with the line. We should know then that the insulation resistance of the line was equal to the known resistance through which (together with the instrument in circuit) the same battery produced the same current. The insulation resistance per mile would then be the total resistance of the whole line multiplied by the number of miles, which in this case we assumed to be ten.

78. It must, however, be pointed out that this rule for calculating the insulation resistance per mile by multiplying the total resistance by the number of miles can only be applied with accuracy to cases where the total insulation resistance of

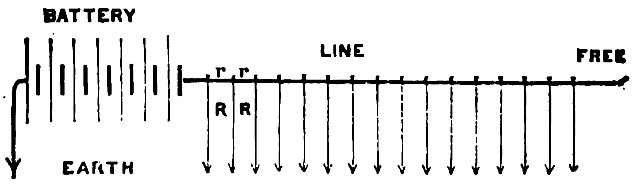

FIG. 42.

the line is very high compared to the resistance of the conducting wire itself, for when this is the case the leakage of current from the line is practically uniform; but where the conductive and insulation resistances approach each other in value the leakage of current will be greatest at the battery end of the line and become less and less gradually along the length of the line, the effect being easily understood by considering the line as made up of a very large number of equal sections, the conductor resistance of each section being r ohms, and its insulation resistance R ohms (Fig. 42). This will be precisely the same state of affairs electrically as the diagram in Fig. 43—that is, the resistances of the sections r and R are connected

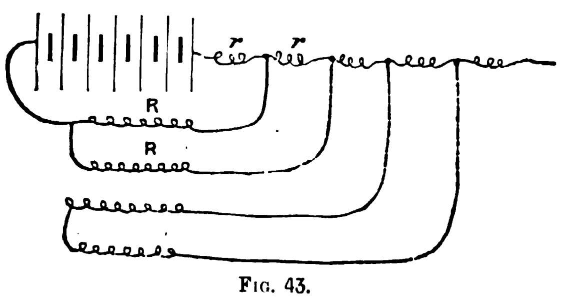

FIG. 43.

up to the battery in exactly the same way. Now it is clear that if the several resistances r r are negligibly small in comparison to the insulation resistances R R, the latter are all virtually connected direct on to the battery terminals, in which case the current through each would be the same—that is, the leakage would be uniform along the line; but if the resistances r r are so high, or R R are so low, that the former cannot relatively be neglected, then each resistance R receives less current as it is further removed from the battery, not only because it has an extra resistance r added to it each time, but because the potential difference between its ends is less each time, owing to the resistance r being added to the previous resistance R. In fact, the first section, $R+r$, is direct on the battery terminals, and therefore receives the highest potential difference, the next section, $R+r$, is connected to R of the previous section, instead of to the battery, hence it must receive less potential difference, and carry less current; and so on through all the sections. We should therefore expect to get less deflection for the same insulation resistance when the conductor resistance approached in value the former than when it was negligible. This is the case, and the insulation resistance therefore comes out too high, and necessitates a correction being applied. Mr. H. R. Kempe, in his "Handbook of Electrical Testing," has worked out in detail the mathematical process in evolving a correction for the above. This correction is applied as follows:—A test is taken of the resistance of the line when the far end is put to earth, which gives the *observed* total resistance of conductor. Now, instead of multiplying the total insulation resistance by the *actual* known length of the line in miles to derive the insulation per mile, the total resistance is multiplied by the number of miles as *calculated electrically* from the above test, the calculated mileage being the

$$\frac{\text{observed resistance of conductor}}{\text{known resistance of conductor per mile}}.$$

For instance, take 300 miles of ordinary telegraph line run with No. 8 galvanised iron wire, known to have a resistance of 14 ohms to the mile, and suppose that on testing this length of line its insulation was found to be 10,000 ohms, and that on earthing the other end and testing for conductor resistance this was found to be 3,500 ohms. Here the two resistances approach each other in value—that is, one cannot be neglected—and therefore the true insulation resistance per mile is 10,000 ohms multiplied by the *calculated mileage*, this latter being $\frac{3500}{14} = 250$ miles. This gives the true insulation per mile to be $10{,}000 \times 250 = 2{,}500{,}000$, or $2\frac{1}{2}$ megohms. If calculated by the ordinary way, the result would have been $10{,}000 \times 300 = 3$ megohms, introducing an error of 20 per cent. The insulation and conductor resistance will approach each other either when the insulation of the line is impaired or a very long length of line is tested. The writer has had occasion to apply the foregoing correction when measuring the insulation resistance of a submerged cable, 1,400 knots in length, in which the total insulation resistance of this great length approached within four or five times the resistance of the conductor. Hence the resistance of the latter was by no means negligible in comparison.

(To be continued.)

ELECTRIC WAVE AND PHASE INDICATOR FOR ALTERNATING AND UNDULATORY CURRENTS.

BY PROF. ELIHU THOMSON.

The purpose of these instruments is to enable us to study the shapes of the waves of alternating currents produced by different machines and apparatus, and also to study the relations of waves in different branches or portions of an alternating current circuit, and the amount of lag or retardation of phase visibly noted.

An iron wire core or bundle, I, (Fig. 1.) is mounted on a stand and arranged so that coils C, C, can be placed upon the core. Sometimes these coils are made with multiple or parallel windings, so that two or more sets of current waves may be caused to act upon the core I simultaneously. One of the coils or one of the windings may, when needed, be used to polarise or magnetise the core I with a definite strength of magnetism, as by a battery current or other continuous current. A diaphragm suitably mounted in front of one end of the core I and constructed of ferrotype metal follows closely the fluctuations of magnetism produced in the core by the currents in the coils. The distance of the core I from the diaphragm can be adjusted. From the middle of the diaphragm a short aluminum wire, flattened out at E so as to be very flexible at that point and connected to a very light but stiff aluminum lever, L, conveys the movements of the diaphragm to the latter. The

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lever L is constructed of flat metal, and placed, as shown, so as to obtain the greatest stiffness with the least weight.

The fulcrum at F is composed of a flattened place in the metal wire, so that it has no lost motion. The connection of the long arm of the lever G has also a flattened place in the wire, and a delicate pivot, H, connects and conveys the movement of the lever L to the small circular mirror M, mounted on a transverse axis and held down against the pivots so as to avoid lost motion by a spring, S, attached to the middle of the back of the mirror, and pulling on the same. The pivotal point H is put a little to one side of the axis on which the mirror swings.

Now, it will be evident by this construction that the slightest movement of the diaphragm D will be followed by a much magnified movement of the mirror M, which mirror, receiving a ray of light, will, as it changes its position, cause such ray to swing over a considerable space on a screen at a distance of 18 or 20 inches away. The beam of light is obtained from a small illuminated pinhole reflected and focussed upon the screen, placed in front of the mirror at, say, a foot or 18 inches therefrom; any movement of the mirror will therefore cause this small round spot to travel up and down in accordance with such movement.

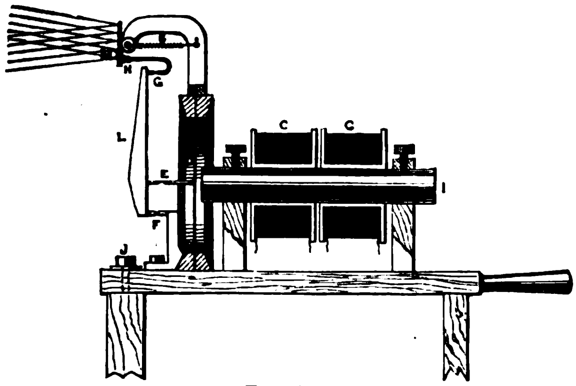

FIG. 1.

If one of the coils of such an apparatus be traversed by alternating currents and the whole apparatus be arranged to swing in a horizontal plane on a vertical axis or pivot at J just vertically under the mirror M, the spot of light will trace out a curve which will approximate closely to the shape of the current wave, much depending on the perfection with which the apparatus has been constructed for the avoidance of much inertia, by making the parts very light, and for the avoidance also of disturbing effects by having the diaphragm D traverse but a very small distance to and fro in front of the core I.

As the core I is of soft iron, unmagnetised, both the negative and positive impulses of current produce movements of the diaphragm towards the core, one by developing north magnetism, and the other by developing south magnetism at its extremity near the diaphragm. The alternating current will therefore produce a wave line like that seen in Fig. 2, in which the dotted line is the zero of current, and the curve of the waves rising therefrom is produced by currents alternately in opposite directions. If, however, a continuous current be passed through one of the coils around the core, and the strength of this current gradually increased, the shape of the wave will undergo considerable alteration, and in one stage will be represented by the wave line shown in Fig. 3, which represents the case of an alternating current passing at the same time with a continuous current in another coil, which continuous current is insufficient to so fully polarise the core I that the diaphragm D cannot be attracted by both impulses. The small wave between the larger waves is an effect produced by the overpowering of the continuous current by the stronger opposite alternating impulses, while the larger waves are due to the combined attraction of the continuous current and the alternating impulses which pass in the same direction around the core. If, however, as in Fig. 4, the polarising or continuous current be made slightly stronger, the wave takes a shape in which the opposite impulses are represented by opposite movements, or in which the upper half of the wave line represents a current in one direction and the lower half the flow of current in the other direction, except in so far as the shape may be modified by the action of the diaphragm itself. The actual appearance presented will be that shown in Fig. 5, in which the curved line is on a black ground, the apparatus, of course, being enclosed in a dark box with an opening opposite the screen for viewing the tracing of the spot of light.

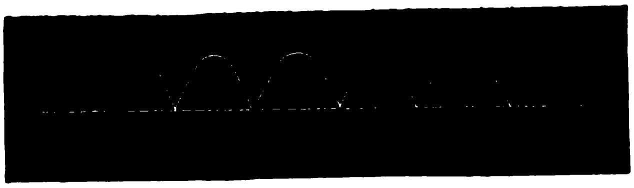

FIG. 2.

If no movement in a horizontal plane be given to the apparatus, the spot of light simply describes a vertical line whose upper and lower extremities are much brighter than the middle (Fig. 6) because of the stoppage of direction of motion which occurs in the spot of light at the upper and lower points of its swing, and of the fact that the highest velocity of tra verse exists in the middle of the swing or when the current is changing from positive to negative, or the reverse. The appearances presented in Figs. 2 to 6, inclusive, are like those which were obtained from an alternating-current machine, the

FIG. 3.

armature of which was without iron projections, such machine being one used in lighting by transformers. Fig. 7 shows a wave line such as was produced by an alternating-current dynamo having iron projections on the armature core. Here, it will be noticed, the curve is of irregular form, though regular in its irregularity. The curve indicates the sudden jumps of E.M.F. at the conclusion of each current wave, and this was undoubtedly due to the forcible pulling away of the armature projections from the field, causing, as a result, a far more rapid passage of magnetic lines across the armature conductors to the next succeeding projection; that is, the magnetism of the field on leaving one projection may be considered to quickly swing over to the succeeding projection, irrespectively of the movement of the armature, and at the same time cut all the wire between the two projections, and thus give rise to a jump or strong impulse of E.M.F.

FIG. 4.

Comparing the curves (Figs. 5 and 7) it will be seen that the armature without projections has given a more perfect wave and that the induction is much smoother, no irregularities of E.M.F. showing themselves. Fig. 8 shows the appearance presented by the spot of light with the same current as in Fig. 7, but with no lateral or horizontal movement given to the mirror. In this case, as in Fig. 6, the spot shows a vertical image or bright line, but instead of the upper and lower extremities being the only points of the line which are bright, the line shows a tendency to the formation of bright spots at other points in its length, and these correspond with those positions in the wave at which the spot of light either hesitates or changes its direction of movement. In fact, the appearance (Figs. 6 and 8) is as though the waves (Figs. 5 and

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7) were composed of a wavy band of light, and were seen on end or in the plane of their propagation.

The apparatus with a single movement of the mirror (Fig. 1) is not well adapted to the study of the relations of the position of phase of two alternating currents, but by adding an additional core with its coils, and an additional diaphragm and lever, and connecting the second set so as to impart a motion to the mirror at right angles to that given by the first set, the capabilities of the apparatus are much extended. The mirror for this purpose is mounted in gimbals, and a connection made from one lever which receives its motion from one of the diaphragms to the mirror, and from the other lever and diaphragm to the surrounding ring to which the mirror is pivoted. All the moving parts are made as light as is consistent with proper rigidity.

FIG. 5.

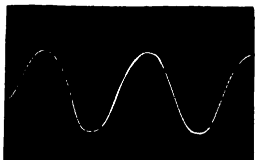


FIG. 6.

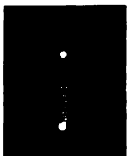


FIG. 7.

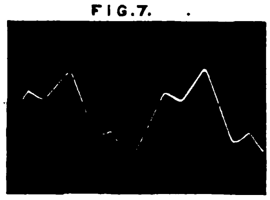
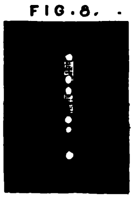


FIG. 8.



Now, if the same current or currents of exactly matched phases act to move both diaphragms and the angular deviations of the mirror be balanced or equal, the mirror will cause the spot of light to travel in a straight line intermediate to the two combined movements given by the two levers.

If, however, the phases of the alternations do not match, or one lags behind the other, the spot of light will describe an ellipse, one of whose axes will be more or less inclined from the vertical. In Fig. 9 Z is the screen, M the mirror receiving the double motion, K a source of light, and N a lens suitable to form on the screen Z an image of a small pinhole at Q. Further, if the condition be such that one of the diaphragms be affected by a current whose retardation of phase is 90deg. behind that of the other, and the currents be of equal value in moving the mirror, a figure approaching a circle will be seen on the screen, which figure would be a perfect circle were the shapes of the waves perfect.

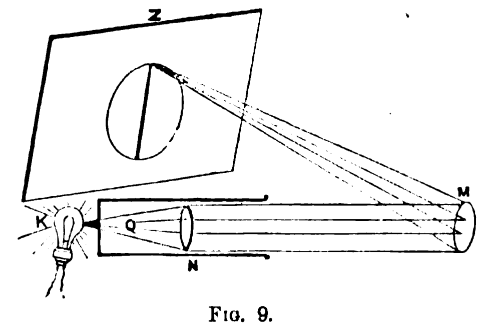


FIG. 9.

In actual trials with the apparatus it has been found that by combining the effects of alternating currents in circuits and branch circuits, a variety of figures, mostly ellipses, the relation of the length of whose axes varied greatly, and the inclination from the vertical of the axes of which also varied greatly, were produced. The changing position of the axes of the ellipses with respect to the vertical, if properly noted, gives an indication of the amount of angular lag or retardation of phase existing in one current as distinguished from the other.

It may be objected that the apparatus itself, on account of its inertia, must give rise to a retardation of the record; but it will be seen that the two diaphragms, levers, &c., being substantially the same in character and dimensions, the inertia or retardation will be practically a constant effect, and that any difference existing can be eliminated by exchanging the currents from one coil and diaphragm to the other, so as to cause them to alternately affect the diaphragms, in which case the mean effect would be taken.

It is outside of the purpose of this description to note all the uses to which this apparatus has been, and may be, applied. A few may, however, be mentioned. In Fig. 10 G represents an alternating current generator feeding a primary line, from which branches are taken off at intervals. T represents a transformer, the load in the secondary circuit of which may be varied from nothing up to full work. The coil C affecting one diaphragm is placed in the main circuit of the generator, and the coil C′ in the branch through the primary of the transformer affects the other diaphragm, the adjustments being made such that the vibratory effects of each, or the amplitude given to the wave movements of the spot of light by each, are equal. In an actual case of this kind it was found that the transformer under no load gave nearly a circle, and therefore showed that the currents passing through the primary had a lag or retardation of approximately 90deg., or one-quarter of a wave length, and this condition was departed from or modified by throwing on the load in the secondary. Space does not permit a full description of the actions, which were, however, very interesting.

Comparisons are also easily made with this apparatus between the positions of phases of the secondary currents and those of the primary currents in the transformer. By the use of a sufficiently bright light, as that of an arc lamp, and sensitive gelatine plates, the figures may of course be photographed.

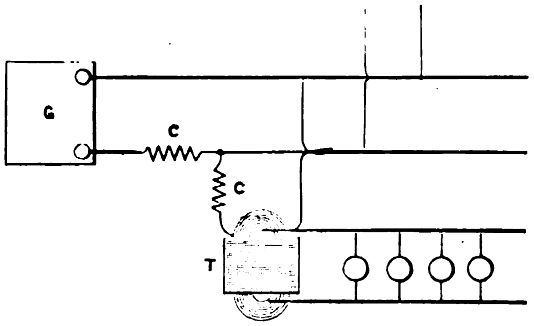


FIG. 10.

The apparatus in either of its forms, single or double, may also be used as an indicator of the extent to which synchronism takes place in two alternating-current machines or sources; or, again, it may be used to indicate the differences of shape of wave produced by such machines. In this case it is only necessary to use the apparatus of Fig. 1, employing a double-wound coil, through which the currents from the two machines pass differentially and produce equal amplitude of vibrations in the spot of light. This can be noted, and adjustment of the extent of swing of the spot on the screen be made with each current separately.

The suggestion may here be made that, having constructed as perfect a machine for generating alternating currents as possible, one in which the spacing of the waves during a revolution is exact, and the amplitudes of such waves the same throughout a revolution, and the form of the wave that which may be considered best in practice, it would be easily possible, by coupling another machine to the first, so as to rotate in perfect harmony therewith, to note the divergences of form of amplitude and position of waves in the two machines.

It will be evident that the curves obtained will only represent the true waves of current when the movement of the diaphragm is proportional, or nearly so, to the current in the coil around the core I. The current at any time will produce magnetism in the core substantially proportional to the current at any instant, which magnetism induces opposite magnetism in the diaphragm; and the pull on the diaphragm would be nearly as the square of the current at any instant when the magnetism induced is far below saturation, so-called. The magnetic pull on the diaphragm is opposed by the elastic force of the same acting as a sort of compound spring against the pull upon it.

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The nature of the effects will also vary somewhat with the distance from the diaphragm at which the core I may have been placed. Whether it will be possible to adjust all variations so that the movement of the spot of light may be in exact proportion to the current whereby the true waves may be obtained is not known.

It is to be understood that, in the use of such apparatus as has been described, the effects of the resistance and self-induction of the coils C traversed by the waves of current should be so small as to have no considerable effect on the currents to insure even moderate accuracy in the indications obtained.

STANDARDISING SIR WILLIAM THOMSON'S BALANCES.

At a meeting of the Physical Society of Glasgow University held on Friday last, an interesting paper was read by Mr. Andrew W. Meikle, who described a course of experiments by which a number of Sir William Thomson's balances were independently standardised by the electrolysis of copper sulphate solutions.

Two centi-ampere balances standardised eight months ago were at that time found to be in absolute agreement when compared with each other. These two instruments have been compared from time to time since that date with a view of checking their relative constancy, and are still in absolute agreement.

Two deci-ampere balances, A and B, were also employed in the experiments. One of these was used to determine the constant of deci-ampere balance A; while the constant of deci-ampere balance B was taken from three separate electrolytic experiments which were in very close agreement, the first differing from the second by $\frac{1}{600}$ per cent., and the second from the third by $\frac{1}{80}$ per cent. These two balances, A and B, when compared together, showed a difference of $\frac{1}{105}$ per cent., while deci-ampere balance A is still in absolute agreement with the centi-ampere balance used to determine its constant. As regards the larger instruments, the results were equally satisfactory. Taking in the whole set of the seven standard instruments, the largest variation of constant for one instrument, when compared with the one next above it, was observed between the ampere and deca-ampere balances, and was then only $\frac{1}{60}$ per cent. Thus, at the time of writing, there was in the Physical Laboratory of Glasgow University, a series of standard instruments capable of measuring from half of a centi-ampere to 500 amperes, all of which were practically speaking in perfect agreement.

REVIEWS.

Practical Physics for Schools. Vol. I., Electricity and Magnetism. By Prof. BALFOUR STEWART, F.R.S., and Mr. W. W. HALDANE GEE. (London: Macmillan and Co., 1888.)

Shortly after the issue of the first volume of the "Elementary Lessons in Practical Physics," dealing with "electricity and magnetism," it was represented to the authors that that work might be made the basis of a class-book adapted for the use of schools. To this suggestion we are indebted for the very admirable little book now before us. The success of the earlier and larger volume has been so marked that no words of ours are necessary to commend the present version to the attention of every teacher of physical science. The value of these class-books, in the excellence of their illustrations and in the lucid exposition both of principles and of phenomena, is apparent, and still more, perhaps, in their insistence on the absolute necessity for the appreciation by the student at every stage of his progress of the quantitative relations involved in the experiments which he is called upon to perform. This feature, which is happily characteristic of the modern school of technical instruction, is in marked contrast with the style of most of the text-books of science of a few years since. "I should be glad," said the late Prof. Fleeming Jenkin in 1884, "if it were generally proclaimed that the elementary training in all our science laboratories should be training in the art of measurement. . . . . You may define the absolute unit of electrical resistance as accurately as you will, and your definition shall affect the average brain to no perceptible extent; but a young man of very ordinary education and intelligence can learn to measure resistances in ohms, and, having learnt this, an ohm becomes a reality to him; . . . [and] having acquired a working faith in the existence of ohms, he is prepared to take some trouble to understand the scientific definition." These wise words of Jenkin might have been placed as a motto upon the title page of these "Lessons;" indeed, so fully do the authors share in this spirit that the "school" version contains a good deal of additional matter, which is concerned almost entirely with the art of measurement. A new chapter has, for instance, been prefixed, under the title of "Introductory Measurements," and containing the following sections:—Units of Length, Area, and Volume; Use of Scales; the Vernier; Use of Callipers; the Micrometer Wire Gauge; the Standard Wire Gauge; the Balance; Method of Using the Balance; Estimation of Density and Time; Unity of Angular Measurement, &c.

The main body of the work is, as we have already intimated, an abstract of the earlier and well-known volume which was issued by the authors under a similar title twelve months ago, and we need therefore say little more about it, though it may perhaps be as well to add that there is nothing in the text to suggest the idea of an "abstract" in the sense of incompleteness. The experiments are described with the same careful elaboration as in the earlier work, and the excisions have chiefly taken place in the purely mathematical sections. A valuable appendix has been added, "On the Requirements of a Physical Laboratory." The equipment of three "model" laboratories is described, with ground plans of their fittings.

With regard to the arrangement of the book we might offer one word of criticism. The authors adhere to the well-established custom of commencing with static electricity, and devote a considerable space to this portion of the subject. We have recently given reasons for a view which we are inclined to hold somewhat strongly—*i.e.*, that static electricity should come last in order, and that the permanent magnet should itself be approached through the electro-magnet. We will only remark here that this is the order in which—as it appears to us—the pupil is least likely to have anything to unlearn as he advances, and in which the lessons may be taken in the most consecutive order.

It is impossible to lay aside this book without feeling an intensified regret that Professor Balfour Stewart passed away from us even before it had been issued from the press. It is to be hoped that his *collaborateur*, Mr. Haldane Gee, will yet carry on and complete the series.

On Difference of Current-Phase, Retardation by Induction and Dissipation of Energy in Transformers. By Prof. GALILEO FERRARIS. (Memorie della Reale Accademia delle Scienze di Torino. Ser. 2. Vol. XXXVIII.)

This is a reprint from the *Proceedings* of the Turin Academy, and contains an account of a theoretical and experimental investigation by Prof. Galileo Ferraris on some points connected with alternating currents. The practical value of the paper is largely discounted by the fact that the observations were confined to open-circuit transformers of the original Gaulard-Gibbs type—a type which it need hardly be said is now entirely obsolete. However, a brief account of the contents of the paper will probably be of interest to many of our readers.

Prof. Ferraris announces by a consideration of the method of determining the difference in phase between any two alternating currents, of the same period, by the use of the two coil dynamometer. This method is really due to Mr. T. H. Blakesley, and was first announced in the columns of this journal in 1885.* As, however, Prof. Ferraris makes no reference to Mr. Blakesley's work, we must presume that he has re-invented the method.

In Mr. Blakesley's memoir it is shown that if a be the ordinary dynamometer reading of the primary current, b the reading for the secondary current, and c the reading when one

* *Electrician*, 2nd October, 1885, p. 390.

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current passes through the fixed coil alone, and the other at the same time through the movable coil alone, then, if ϕ be the angle of lag,

$$\cos\phi = \frac{c}{\sqrt{a\,b}}.$$

Professor Ferraris prefers to use three independent dynamometers, so as to take all the readings simultaneously.

The transformer used for the experiments was of the original open magnetic circuit Gaulard-Gibbs type, constructed for two horse-power, and had a movable core. The current was obtained from a Siemens alternating dynamo, and the electrodynamometers were of the form made by Siemens and Halske for use with strong currents. The table below, in which n is the number of revolutions of the dynamo, and r is the total resistance of the secondary circuit of the transformer, gives the results obtained in the first series of experiments :—

N	r	a/b	c/b	ϕ
603	0·409	1·026	1·010	175° 30′
605	3 224	1·215	1·054	162° 59′
601	5·713	1·561	1·082	150° 0′
609	8·542	2·152	1·109	139° 7′
610	11·000	2·923	1·142	131° 55′
6(2	14 790	4·969	1·203	122° 40′

Now, according to the elementary theory of the transformer (*see* Mascar et Joubert, "Leçons sur l'Electricité et le Magnétisme," Vol. I. p. 593 *et seq.*), based on the assumption that there is no retardation in the magnetisation and demagnetisation of the iron ; that there are no Foucault currents ; that the coefficients of induction are constant, and that both the primary and secondary currents are sinusoidal, a/b, c/b and ϕ should be constant, whereas the table shows that they are functions of r. The discrepancy cannot be due to variation in the coefficients of induction as the saturation of the iron diminishes, for in that case their ratio would be constant, which would make these three columns constant. The author therefore considers the theory of the transformer when magnetic retardation is taken into account, and finds that the experimental results then show a very close agreement with his theory. He points out that one cause of the retardation is hysteresis in the iron, and he then proceeds to investigate the effect of the Foucault currents. These in their generality cannot be submitted to analysis, but he obtains a first approximation to their action by considering the action of a single alternating current through the core and other metallic portions of the transformer, and he shows that its result would be to cause an additional retardation, and he finds by experimenting with different cores that the retardation from this cause is diminished by increasing the internal resistance of the core, which is not perhaps a very novel conclusion.

The author shows that a very simple relation exists between the dissipation of energy and the retardation of the secondary current, namely, if we write $\frac{\mu T}{2\pi}$ and $\frac{\lambda T}{2\pi}$ for the coefficient of mutual induction of the two coils, and the coefficient of self-induction of the secondary coil respectively, the values being those obtained experimentally with alternating currents, and if P be the amount of energy dissipated, and Q the amount developed in the secondary circuit in the same time, r the resistance of the secondary circuit, and if τ be the retardation, then approximately

$$\frac{P}{Q} = \frac{r}{\lambda}\sin\frac{2\pi}{T}\tau = \frac{\mu}{\lambda}\left(\frac{c}{b} - \frac{\lambda}{\mu}\right)$$

So that within the limits between which $\frac{1}{\lambda}\cdot\sin\frac{2\pi}{T}\tau$ is practically constant, the ratio P/Q is simply proportional to r; but the former quantity increases as r increases, so that as r increases the ratio P/Q increases more rapidly. The expression for P/Q shows that for a given value of r and a given transformer the loss of energy is diminished by increasing the speed of alternation, and also by increasing the self-induction of the secondary coil. It also follows that the efficiency determined for a given speed of alternation will not give the value for another speed of alternation, which is, however, obvious from quite elementary considerations.

The author determines the ratio P/Q for a value of $r = 6$ ohms, and with the same speed of alternation with five different cores, and found results of the kind which might readily have been predicted. With a well laminated core the ratio $\frac{P}{Q}$, or $\frac{\text{waste}}{\text{work}} = 0{\cdot}07$, and with a solid bar of iron it rose to 0·9.

INSTITUTION OF MECHANICAL ENGINEERS.

THE POSITION AND PROSPECTS OF ELECTRICITY AS APPLIED TO ENGINEERING.

BY MR. W. GEIPEL.

At the forty-first annual general meeting of the Institution of Mechanical Engineers, held at the Institution of Civil Engineers, Mr. WILLIAM GEIPEL, of Edinburgh, read a paper, of which the following is an abstract :—

In the present paper the author purposes confining his remarks to those branches of electric engineering which involve the employment of considerable power and are in some way connected with the use of dynamo machines. The principal of these may be treated under the four following heads :—

I. Electric Transmission and Distribution of Power.
II. Electric Locomotion.
III. Electric Lighting.
IV. Electric Metallurgy.

I.—ELECTRIC TRANSMISSION AND DISTRIBUTION OF POWER.

In the near future this branch of electric engineering will probably occupy more attention and call forth more outlay of capital than either of the three others mentioned above ; already, indeed, it is commanding a great deal of attention. Owing to its simplicity, the ease with which an electric motor can be applied to any purpose requiring power and its high efficiency, is certainly an approach to an ideally perfect system of transmission. No greater contrast can be imagined than the difference between the position of electricity in this country and in America. On the other side of the Atlantic, although the science of electricity is much behind, the practice is far ahead of our own. European science has supplied an agent, the value of which has been recognised by American engineers ; and now in the United States the applications of electric motors are already rivalling and will soon excel in importance the application of electricity for lighting purposes. It is to be remembered, however, that there, owing to the high price of coal, the use of steam-power is a more serious consideration than here ; they have also in many places abundance of water-power which can be utilised by electric transmission. Notwithstanding these differences, there is in our own country an almost unlimited field for the employment of this mode of transmitting power cheaply to a distance, and of distributing power generated at a central station to a number of users in the neighbourhood.

Were it not for the cost of the dynamos and motors, electricity would supersede to a great extent the use of belts and shafting. In large works, where high speeds are required and the demand for power is variable, the efficiency of belts and shafting is very low indeed. As much as 25 per cent. of the power may be absorbed by the shafting when the full number of machines are in use ; and in such a case with half the machines in use the loss of power rises to nearly 50 per cent., while in the extreme of driving only a single machine even 99 per cent. may be lost. With electricity, on the other hand, no power is being used in keeping the transmitting medium in motion, the conductor being stationary ; the loss takes place only whilst power is actually being used by the motors, each of which drives its own machine. In fact, the percentage of power lost in the transmitting medium becomes smaller as the amount of power transmitted is reduced, which is exactly the converse of what happens with belting and shafting. For the sake of illustration and comparison, let it be assumed that a loss of 25 per cent. of power would take place in the electric conductor when the full load is on ; although in reality the loss would never be above 10 per cent., and need not be more than 5 per cent. Then with half load the loss would be 12½ per cent., and so on ; and with one machine possibly one-tenth of 1 per cent. might represent the loss in the conductor. When it is remembered in how many cases the average load in a factory is less than half the maximum, it is evident that this point is one demanding the greatest consideration. In New York, where a large number of motors are supplied with current from the electric light mains, it has been found by experience that on an average less than one-third of the whole number of motors are in use at any one time.

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The depreciation of the electric conductors is comparatively small; but whether the saving of renewing belts and of lubricating shafting would not be counterbalanced by the wear and tear of motors is a question to be settled by individual experience. The advantage, however, of getting rid of shafting, thereby obviating the necessity for additional stability in the building and doing away with constant lubrication, and the further advantages of saving the space and light absorbed by belts, and of the ease with which the conductor can be shifted to suit any desired alterations in position of machines, are also very important matters.

The distribution of power by electricity from a central station to small users will, in the author's opinion, form in many towns a larger business than the lighting. Both can be done from the same mains and generators, just as is the case with gas; it is merely a question of economy and convenience as to whether gas or electricity should be used. The encouragement of small industries has long demanded some cheap means of obtaining power in small quantities, say from ½ to 25 horse-power. The gas engine has not altogether met the requirements of small establishments, although needing but little attendance; for the first cost of even a small engine is high, and the amount of gas consumed is large. Moreover, the speed is generally irregular, owing to the intermittent impulse, which is more especially noticeable with light loads; and a considerable amount of wear and tear takes place in the valves and working parts.

An electric motor can be started and stopped at will with the greatest ease; it requires the smallest amount of attention, occupies the minimum of space, and can be placed in almost any position. An ordinary shunt-wound motor will run at an almost constant speed, with a maximum variation of only 5 per cent. from running light to fully loaded; this fact was first pointed out in an interesting paper in the *Philosophical Magazine* for January, 1886, by Mr. Mordey, who has done much valuable work in the perfecting of the modern dynamo machine; he has kindly sent me a diagram, showing the result of some tests of a Victoria motor for change of speed under variable load, which illustrates the remarkable constancy of speed attained. This exceedingly close regulation was obtained by using a simple shunt motor of suitable construction, and without any accessories such as the many forms of governing devices to which so much attention had previously been devoted. The result shows that such a motor possesses a practically perfect power of self control, not only over its rate of speed with varying load, but, what is of equal importance, over the energy absorbed by it; for it helps itself, as it were, to only such an amount of energy as will enable it to deal with the work imposed on it. A 1 horse-power motor will cost £20 against £100 for a gas engine. The cost of running a gas engine is about one penny per horse-power per hour for gas alone; the same power generated by a dynamo driven by an efficient steam engine costs only about one farthing, current being supplied from street mains just as gas is.

As small steam engines are being superseded by gas engines wherever the outlay for the latter can be afforded, the competition in regard to small powers lies between gas and electricity, and steam may be left out of the question. There is, of course, a limit above which steam becomes the cheapest; and probably 10 horse-power may be taken as about that limit in this country. In Boston, in the United States, where some hundreds of motors are supplied with electricity from central stations, they range from half to 15 horse-power, and are working lifts, printing establishments, small machine shops, and watch-making, tailoring, boot-making, and similar industries. Their working seems to be highly appreciated; and the author understands the users would be willing to pay even 25 per cent. more for them in consequence of their convenience and regularity in working. In Geneva,* within a radius of a mile and a quarter there are no fewer than 175 motors at work, varying from ½ to 70 horse-power, supplying power to small workshops, and for other purposes, the electric power being obtained from dynamos and turbines, which are driven by water power derived from the Rhone. The installation is paying its way, and is about to be largely increased. At the Falls of Niagara plant is being put down to distribute power obtained from the Falls to neighbouring towns, including Buffalo, which is twenty miles distant; the amount of power is stated at 15,000 horse-power, of which 10,000 horse-power is contracted for at £3 per horse-power per annum for power and lighting purposes in Buffalo.

As an interesting example may be mentioned a 6 horse-power motor recently erected by the Brush Company of Cleveland, Ohio, in a printing establishment, where it was connected with the regular arc-light circuit. It takes the place of a 10 horse-power steam engine, which had sometimes come to a standstill under its load. It drives about 70 to 80ft. of shafting, three cylinder presses, four platen presses, one large paper-cutter, and one very heavy lift; and by a 4in. belt carried up through three floors it also drives three ruling machines and four paper cutters. It does its work splendidly, and its motion is steady and regular. It has proved to the proprietor's satisfaction that printing offices could well afford to employ electricity instead of steam, even in cases where the first cost might be more. In many other towns in America, where the electric-light mains are within reach, the number of motors already in use is very great; within two years 5,000 motors have been supplied by one firm alone, and the author understands that the Brush Company are turning out as many motors as dynamos.

In some places in this country, and more especially in Lancashire, it is customary for power to be supplied from a large steam engine to neighbouring buildings, which are let out as separate workshops. In such instances, however, the power supplied is more frequently above than below 10 horse-power, and probably it would not pay to introduce an electric motor. Still, it should not be forgotten that in renting these workshops considerable inconvenience may be incurred as regards the locality of the premises for the manufacture; moreover, the rent is often disproportionately high.

Many schemes have been propounded for distributing power in manufacturing districts by means of steam, compressed air, and water pressure, each of which is in use to a somewhat limited extent; and as all of them have been known long enough, it may seemingly be inferred from their limited employment that there is not much to recommend their extended use commercially. With steam, the condensation in the pipes causes loss of pressure, and results in wet steam being supplied to the engines. Compressed air cannot efficiently be worked expansively, and is attended with loss of heat in the compressor. Water pressure commonly involves using the maximum power, whatever the work required. Besides these prominent faults of the three several methods, what is of the greatest importance and common to all three is that the generating plant has to be used almost exclusively for supplying the power, and cannot be utilised for other purposes in addition; whereas with a central electric station the engines and dynamos serve to generate current for lighting purposes also at night.

Collieries.—In collieries electricity will be largely adopted in the near future. For underground hauling, pumping, ventilating, and drilling, it can readily be applied with an efficiency double that of compressed air. With a well-arranged installation 75 per cent. of the brake power of the engine will be utilised on the shaft of the motor.

For hauling and pumping, wire ropes or rods are the greatest competitors of electricity, which obviates the following disadvantages in connection with them: chance of breakdown through strain; wear and tear; mishap to guides through falls of roof or dirt; trouble and expense of oiling the guides; and room required at pit mouth or at bottom for engine, pulleys or levers, or other gear. As the tendency in mines in this country is towards a reduction of working hours, the question of mechanical haulage becomes most important, because horses must be fed whether at work or idle, and the cost of haulage by horses therefore increases as the working hours become reduced.

For ventilating and drilling, compressed air is perhaps most largely used; and one of the great points in its favour is that the exhaust is available for supplying fresh air to the miners, and for driving out the foul gas after the firing of shots. But the cost of the compressed air machinery is heavy, as is also that of the pipes for conducting the compressed air from the compressor to the place where it is used. The cost of electric plant is somewhat less, and the efficiency is very much greater; while by using old haulage ropes as conductors the cost of this item is rendered very small.

At Trafalgar Collieries, in the Forest of Dean, there is an interesting instance of pumping on a small scale.*

Another interesting example of pumping is afforded by the recent introduction of electricity for this purpose into St. John's Colliery, Normanton.†

At Thallern Colliery,‡ on the Danube, where electricity has replaced steam for pumping, it has been found after several months' work that a considerable saving in coal is effected; also that the temperature of the pit is reduced some 14deg. F., steam having previously rendered the atmosphere of the mine unbearable.

In the mines of Blanzy,§ in France, a ventilating fan is driven from a generator at bank. The fan is 150 yards in, 2½ft. diameter, by 11¾in. broad, and runs at 730 revolutions per minute. The temperature at the face has been reduced 15deg., from 95deg. to 80 deg. F., since its introduction.

Shipyards.—In shipyards and similar works electricity has already proved itself a suitable and economical means of transmitting power for riveting, drilling, &c. The electro-magnetic tools described in Mr. Rowan's paper at last year's summer meeting (*Proc.* of Mechanical Engineers, 1887, page 323)‖ are being successfully employed in yards at Dumbarton. This system possesses the

* See *Electrician*, December 9, 1887, p. 106.

* See *Electrician*, March 4th, 1887, p. 378.
† See *Electrician*, November 18th, 1887, p. 34.
‡ See *Electrician*, March 4th, 1887, p. 378.
§ See *Electrician*, March 25th, 1887, p. 439.
‖ See also *Electrician*, June 3rd, 1887, page 73.

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additional advantage that the tool can be firmly held to its work by magnetic attraction alone, without the use of bolts, so that no holes need be left for hand riveting as is required with other machine riveters.

Transmission to Great Distances.—The transmission of power to great distances is not of such vast importance here as in the colonies, although even in the small sluggish rivers of this country there are large amounts of power running to waste. In many places where works have been erected for utilising water-power, it has been at the sacrifice of convenience of situation, or of a ready and cheap means of receiving and despatching goods; whereas by means of electricity the same water-power might have been transmitted to a locality more suitable for the works. For short distances it does not pay to transmit water-power by electricity, owing, as previously mentioned, to the cost of dynamos; in such cases transmission by shafting or wire ropes is cheaper. But for long distances shafting is out of the question, wire ropes become more expensive, and electricity is cheapest.

As an interesting instance of the transmission of power by electricity over long distances, that at the Phœnix Gold Mines* in New Zealand may be referred to. The current is generated by two No. 8 Brush machines, each capable of giving 20,000 watts or 26 horse-power; they are driven by Pelton water wheels, with a head of 180ft. The current is conveyed to the motor about three miles distant, and back again, by a No. 8 B.W.G. copper wire (0·165in. thick) nearly six miles long, supported on telegraph poles. The power lost in the line is only 3 horse-power. A Victoria motor is used, running at about 350 revolutions per minute; and the power is transmitted to the machinery by a belt.

Mr. C. E. H. Brown, of Oerlikon, has succeeded in transmitting by electricity 50 horse-power from water at Kriegstetten over a distance of five miles to Solothurn in Switzerland, with a commercial return of over 70 per cent. Two series-dynamos and two series-motors are arranged on the three-wire system. Each of the three wires is ¼in. diameter, consisting of bare copper suspended on poles about 40 yards apart, with fluid insulators for ensuring good insulation. For a span of 130 yards across the River Aare, silicium-bronze wire is used, which has the same conductivity as copper and a tensile strength of 30 tons per square inch. The current used is 15 amperes, and the potential difference at the terminals of each dynamo is 1,250 volts. The resistance of the line is 10 ohms, and the loss in it is a little over 3 horse-power, or 6 per cent. of the total power. The loss in dynamos and motors is 24 per cent., being much less than in Deprez's machines, where it was 44 per cent.

At Hatfield, on the Marquis of Salisbury's estate,† the River Lea is utilised to generate electricity, which is transmitted to the house and over the estate for a variety of purposes. Two turbines are used—one to drive a 40 horse-power Siemens alternating-current dynamo, for lighting the house; and the other to drive a 16 porse-power Brush machine, for arc-lighting at night, and in the day for working the motors at the house and on the farm. Those at the house drive pumping and ice-making machinery, and a 24in. Blackman air-propeller fixed in the roof for ventilating; on the farm the motors are used for elevating hay and corn sheaves to the tops of the stacks, for thrashing, for cutting rough grass with a chaff-cutting machine for ensilage, in fields extending to a distance of two miles, for grinding corn, &c., to make fodder, and for other purposes. The motors have also been used for pile driving, for making cofferdams where necessary in the river; and also for dredging the river and clearing it of weeds. A Gramme motor, capable of raising 2,500 to 3,000 gallons per hour, pumps the town sewage into a tank at a height of 30ft. for irrigation. The conductors are carried overhead on poles about the farm, and underground in wooden troughs to the house.

II.—Electric Locomotion.

The practical methods of accomplishing electric locomotion seem to the author to be the four following:—

Firstly, the use of a third insulated rail or conductor to convey the current from the generator to the motor carried on the locomotive, contact being made by a wheel or a sliding spring or brush; while the two ordinary rails serve as a return circuit, the current being conducted from the motor to the rails through the frame, axle, and wheels of the locomotive.

Secondly, the employment of an overhead conductor supported on poles or from the roof of an arch or tunnel, contact being made either by a carrier on wheels running along the conductor, or by rubbing. The return circuit may be either through a second overhead conductor or through the ordinary rails, as in the third-rail plan.

Thirdly, the use of an underground insulated conductor, placed in a conduit between the rails, and conducting the current from the generator through a contact carriage to the motor, whence it is conveyed back through the frame, axle, wheels, and rails.

Fourthly, the employment of storage batteries, placed preferably under the seats of the car with the motor and gear underneath, or the whole placed on a separate locomotive.

The plan of using the ordinary rails as positive and negative conductors, and insulating the wheels or axles of the car, is attended with the objection that, owing to the rail supports having to carry heavy loads, there is difficulty in insulating the rails sufficiently to prevent excessive leakage to earth.

Of these four methods the first two are the cheapest and most efficient, but are applicable only to railroads; while the two other plans, of an underground insulated conductor and of storage cells on the car, are both applicable to street tramways.

Gearing.—Owing to the high speed at which electric motors require to run, and the limited space available for them to occupy, the mode of gearing the motor to the axle of the locomotive or car forms an important consideration, more especially in places where the motor is placed upon the car which carries passengers, when noise and vibration would be most objectionable. The following five methods of gearing are those more generally employed:—(1) worm-wheel gearing; (2) pitch-chain gearing; (3) leather belting; (4) rope, either endless or not; (5) toothed wheels.

Worm gearing appears from Mr. Holroyd Smith's experience at Blackpool,* where his electric tramway is worked with an underground conductor, to be the best for tramcars. Although as a rule it is not efficient, yet if well designed and properly lubricated it can be rendered more efficient, and probably is fairly suitable for this purpose. Some tests made by Mr. Reckenzaun show a maximum efficiency of 87 per cent. The author thinks that a combination of toothed wheels and friction gear, such as has been introduced by Mr. Raworth for driving dynamos in electric lighting with excellent results where space is a desideratum, would make a silent working and durable form of gear; the friction gear would serve to reduce the speed from the motor to a countershaft; and from the latter the driving wheels of the car would be driven by toothed wheels. The form of gear employed of course depends greatly upon the nature of the traffic and of the rolling stock.

Third Insulated Rail.—As an example of an electric railway with a third insulated rail, that at Portrush, Ireland,† is probably the most interesting, as being one of the first started in the world and also the longest; its total length is six miles. Power is generated by two 50 horse-power turbines, driving a dynamo which is capable of generating 100 amperes at 250 volts; the current is transmitted from the River Rush through a distance of 1,600 yards to the railway, the resistance of the line being 1·9 ohm. Pitch-chain gearing is used, and gives satisfaction. The working expenses amount to less than threepence per car mile.

Another instance, also in Ireland,‡ is the Bessbrook and Newry tramway, which is three miles long and 3ft. gauge, and is actuated by water-power. The accompanying photographs showing the arrangement of the cars have been kindly lent by Dr. Edward Hopkinson, to whose designs the railway was constructed. A turbine which develops 62 horse-power drives two Edison-Hopkinson dynamos, each capable of giving out 25 horse-power at 250 volts. The third rail is of channel-section steel, supported in wooden blocks which apparently act admirably as insulators, the leakage being only ½ ampere per mile, or 0·3 horse-power in all. A train consists generally of one passenger car constructed to carry thirty-eight persons, and three goods waggons, each carrying 2 tons freight. The maximum speed that can be attained is 15 miles per hour. Here also chain gearing is employed. The cost per train-mile is 3·3d. during the busy months, and 4·2d. in slack months; these figures, however, do not include anything for depreciation on the cost of construction of the railway, which was £2,500, nor for general supervision.

Overhead Conductors.—The electric railway at Moedling, near Vienna, is a good example of the employment of overhead conductors. The number of passengers carried during the year 1886 was 342,257, according to Mr. Reckenzaun, and the average cost 3·42 pence per car-mile; the coal consumption per car-mile was 13·4lbs. of very inferior brown coal. The current is generated by six Siemens dynamos, driven by three portable engines of 12 nominal horse-power each; the use of these engines may account for the somewhat high consumption of coal. The overhead conductors, which are carried on posts 18ft. high and 90ft. apart, consist of slotted tubes in lengths of 15ft. each, soldered together; a contact carriage slides within the tube, which is 1in. diameter inside. Spur gearing is used, but apparently is not satisfactory; the objections to it are the rapid wearing out of the high-speed pinions, the great weight of the gear, and the noise and vibration caused.

* See *Electrician*, July 16th, 1886, p. 191.
† See *Electrician*, April 15, 1887, p. 511.

* See *Electrician*, September 10th, 1886, p. 370.
† See *Electrician*, April 14th, 1883, pp. 523, 545; also Oct. 27, 1883, p. 567.
‡ See *Electrician*, Dec. 9th, 1887, p. 104.
§ See *Electrician*, April 22nd, 1887, p. 527.

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The Frankfort Offenbach* electric railway, which was opened for traffic on 10th April, 1884, is similar to that at Moedling, the current being brought to the moving cars by means of slotted iron-tube conductors carried overhead. The length of the line is about 4½ miles; the gauge is 1 metre (3ft. 3⅜in.). The sharpest curve has a radius of 98½ft.; the steepest incline is 1 in 30, and only 18 per cent. of the line is level. The average speed of the cars is 7½ miles per hour. Two cars coupled together start from each end of the line every twenty minutes. Each car has seats for eighteen passengers and standing room for twelve more, the gross weight being four tons. The motor is placed under the floor of the car, and the connection to the wheels is made by toothed gearing. The generating station is at Ober-rad, about the middle of the line, and contains one twin engine of 240 indicated horse-power, and one spare engine of 80 to 100 indicated horse-power; in regular work one cylinder only of the twin engines is used, giving off 120 indicated horse-power. The current is generated by three Siemens dynamos, called 300-light; a fourth similar dynamo is in reserve. The working electromotive force is 350 volts. The current generated by the three dynamos is sufficient to keep eight cars running simultaneously.

This plan has been most largely adopted in America, where there are probably not far short of one hundred electric railways at work and projected. It has certainly the recommendation of cheapness, for a higher voltage is permissible, and consequently a smaller conductor with less loss of power than in the case of the third rail; this is more especially important for long lines. As an instance of what is being done, a railway of eleven miles length is now in course of construction at Richmond, and forty cars are building to be worked upon it on the overhead system. Another instance is the railway at Scranton, Pennsylvania, which has been in successful operation about a year. It is 4½ miles long, five cars carrying motors from 15 to 20 horse-power are in use, and four cars with 25 horse-power motors are being constructed, each of which will be able to draw two others; the cars carry seventy-five passengers each. The current is generated by two 100 horse-power dynamos, driven by two 180 horse-power engines, one set being spare; the potential adopted is 600 volts. The overhead conductors are of copper $\frac{5}{16}$in. diameter; the supporting poles are 100ft. apart, about 20ft. high, and about 6in. diameter at the thick end; the return circuit is through the ordinary rails. The plant is also used for lighting the town. The potential generally employed in America for the longer lines is from 500 to 600 volts; the latter is probably the limit to which it is safe to work. With this potential two ⅜in. copper conductors would serve to work twenty-five cars in parallel, the current per car averaging about 10 amperes. With a voltage as high as this the leakage on the third-rail system would be excessive.

Underground Conductor.—Perhaps the most important example of this plan is Mr. Holroyd Smith's electric tramway at Blackpool,† which has been in successful operation for some two years. The underground conduit is somewhat similar to that of a cable tramway such as is working at the present time in Edinburgh and on Highgate-hill, London; but instead of the carrier being used to grip a running cable, it is made to rub along a stationary conductor. The cost of working is stated to be less than fourpence per car-mile; during one week in the season of 1886 there were 44,306 passengers carried at a cost of £45 for wages and fuel, which is less than one farthing per passenger.

Where an underground conductor is employed, the advantages of having no slit communicating with the surface of the street are so obvious that an ingenious plan has been proposed by Mr. Frank Wynne for placing the conductor in a hermetically sealed conduit under the line.‡ A small carrier, which acts as a contact-maker between the conductors and short sections of rails laid in the road, travels along the conduit, being actuated by a tiny electrometer and by part of the same current which works the tramcar above it. An absolute synchronism between the tramcar and the carrier is obtained by a simple device. The short sections of rails are in circuit only whilst the car is over them.

A plan has been proposed by Messrs. Ayrton and Perry§ for making contact between the underground conductor and the section of rail underneath the car by means of the weight of the car, which actuates an arrangement of levers that make the contact so long as the car is on that section. A plan has also been proposed by them for employing the attraction of a magnet fixed on the car, and keepers fixed in boxes underneath the street. The contacts on the keepers are permanently connected with the underground conductor, and when lifted by the attraction of the magnet on the car they make connection with a section of rail, putting the motor in circuit.

(To be continued.)

* See *Electrician*, April 22nd, 1887, p. 527.
† See *Electrician*, Sept. 10, 1886, p. 370.
‡ See *Electrician*, Nov. 25, 1887, p. 45.
§ See *Electrician*, Feb. 24th, 1883, p. 355.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

STUDENTS' MEETINGS.

At a meeting of students on January 19th, F. H. Webb, Esq., presiding, the report of the committee was read and adopted, also the following gentlemen were elected to form a Students' Committee for 1888:—

Mr. C. G. Lamb, B.Sc., Mr. R. W. Paul,
Mr. Chas. Priest, Mr. E. G. Tidd,
Mr. J. N. Cooper, Mr. A. G. Sanders.
Mr. J. Rance, jun., Hon. Sec.

Mr. J. N. Cooper then read a short note upon "An Error Due to Refraction in Mirror Galvanometers." A short discussion followed, in which Messrs. Paul, Smith, and Lamb took part.

February 2nd.—Prof. J. A. Fleming, D.Sc., in the chair. Mr. C. G. Lamb, B.Sc., opened a discussion upon the recent papers on voltmeters. Messrs. Gimingham, Smith, Bate, Paul, Dykes, Cooper, and Dr. Fleming discussed the subject, and after Mr. Lamb's reply the meeting was terminated by thanking Dr. Fleming for presiding.

The council of the society has resolved that students tranferred to the class of associates shall be permitted to attend students' meetings for one year after the date of such transfer.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Jan. 28th*, 1888.

Dr. Norvin Green, president of the Western Union Company, who has just appeared before the Post Office Committee of the United States Senate, expresses his belief that we shall have no Government telegraphs in this country at present. Although considerable agitation on the subject is going on, he believes that the actual sentiment in favour of the scheme is really not so great as it once was. In the course of his evidence he pointed out that the average cost of a message to the public had fallen from $1.05 in 1867 to 30½c. in 1887, and he volunteered the information that rates are to be reduced again this year. He also believed that the deficit of such a Government system as has been suggested would be from $5,000,000 to $10,000,000 annually. He asserted that under a Government system no compensation was made to aggrieved parties for "bulls" and blunders in their messages, whereas the Western Union Company paid out from $100,000 to $200,000 a year under this head of expenditure. He characterised Governmental telegraph service as being generally poor and inefficient, and he held that if the Western Union Company be a monopoly—which he denied—its control of vast capital and plant had enabled it to do work that was without parallel anywhere. He mentioned also the interesting fact that no fewer than 3,000 people directly, and 20,000 indirectly, are interested in the stock of the Western Union Company. Dr. Green was followed by Mr. Gardiner G. Hubbard (the father-in-law of Prof. Bell), a gentleman greatly interested in the subject of postal telegraphs. It might be supposed that Mr. Hubbard's pecuniary interest in the telephone would give him some opinion of this subject, but whatever the reason of his advocacy there can be no doubt that Mr. Hubbard is very much in favour of Government control of the telegraphs. His idea is that the Post Office department should receive telegrams, just as it does letters, that it should further make a contract with competent parties to transmit the telegrams, and that the Government should then deliver the telegrams, the post office in country towns being also, as in England, the telegraph office. All telegrams are to be prepaid on this system by Government stamps. He advanced various arguments, more or less familiar, in favour of this plan, and made the statement that while it was true English operators were paid less than American, the American offset this by sending 2,500 words to the Englishman's 800. What have your readers to say about that?

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Speaking of the juxtaposition of these two gentlemen in Washington, reminds me that wild rumours have been afloat during the past week as to an approaching rupture between the American Bell Telephone Company and the Western Union Company, the ground of trouble or warfare being the continued extension of the long-distance telephone lines. One of the reports in circulation went so far as to allege that the Western Union Company intended to take up the McDonough telephone and use it as a weapon against the Bell Company. It will be remembered that the Western Union Company is not a stranger to the telephone business, but had at the time it made its compact with the Bell Company a large number of exchanges in operation. It is generally understood that the McDonough telephone stock is held largely by Mr. E. S. Stokes, who is now at the head of the Postal Telegraph Company, which has some kind of working arrangement as to rates with the Western Union Company. I need hardly say that all these rumours have been very positively contradicted; but there are a good many people who believe them on the ground that where there is smoke there is fire. There seems to be no question as to the preference given to the telephone over the telegraph for private lines, and the long-distance company in New York has now a large number of such lines in operation.

I made note some little time ago of the onslaught of the newspapers in Chicago upon the local telephone company. The scene now shifts to St. Louis, where a movement has been begun to cut the rates in two. A petition, signed by a large number of the leading firms, has been addressed to the municipal authorities, asking that a Bill or ordinance be passed fixing the rate at $50 a year instead of $100. It is not known how far this agitation is likely to be successful. It is safe to say that the local telephone company will resist it. The Law switch-board system is in use in St. Louis, and from personal observation I can say that the service is excellent. Mr. Durant, the manager, is an enthusiast about his work, and spares no pains to treat his *employés* well, or to please the public. Ever since the destruction of his central office by fire in 1885 he has been hard at work increasing the efficiency of his system, and it seems a little hard that just as he has succeeded he should be met with this attempt at a reduction of rates. The exchange has, I believe, about 2,000 subscribers, and its list of the daily work of the exchange averages 15,500 connections, bringing 31,000 stations into use. Mr. Durant is quite statistically inclined, and has recently constructed a chart showing the fluctuations in five-minute periods of 10 hours' traffic from a group of 89 subscribers. The average number of the connections as the result of the experiment was—per minute, 1·94; per five minutes, 9·72; per hour, 116·7.

A large number of motors are now being installed in this city, and the prospects are that the demand will increase very rapidly. In one case, where an isolated Edison plant is to be put into some large car stables, Sprague motors are to be used for running the elevators, cutting the hay, and driving various machinery in the blacksmithy and the forge shop. In this way the plant will do double service, and a little bit later we may expect to see it charging batteries to drive storage cars on the road. Another case of novel work is that mentioned in the motor catalogue recently published by the Brush Electric Company. A Brush motor drives the dough mixers in a large bakery, taking its current from the street circuits, and the parties who use the motor are very well satisfied with the results obtained. A suggestion is now being made that the fire departments, instead of using steam engines, should resort to electric motors for attaching the pumping apparatus, and it is not at all unlikely that something of the kind will be tried; in fact, a departure in this line has already been made by the Sprague Company, which is building a stationary electric motor fire outfit for the palace of the Mikado of Japan. The growing importance of electrical enterprises is now recognised by the public and by legislators, and the latest sign of this appreciation is found in a Bill introduced into the New York Legislature which proposes to place all the telephone, telegraph, electric light, and other companies under the care of a commission, which is to consist of eight members to be nominated by the governor and confirmed by the Senate. This Bill was before the Legislature last year, but is revived this, and, it is said, with more prospect of success. In Massachusetts the electric light companies are placed under the supervision of the gas commissioners, who have made their report this week, to the effect that in that one little State there are no fewer than fifty-six companies now engaged in supplying electric lights.

Now that we have our subways we are beginning to experience some of the troubles and drawbacks that attach to them. Last week a bad accident occurred in one of them on Sixth Avenue uptown, where two men, working in a manhole, became suffocated by the illuminating gas that had leaked in, one of the men being dead when taken from the hole. So great is the accumulation of gas that when working in these manholes it is necessary to fan it out; but on this occasion, the weather being extremely cold, the precaution was neglected. It has begun to be feared that New York will have the experience that other cities here have already enjoyed, of seeing its electrical subways damaged by frequent gas explosions, with serious results.

I do not know whether you in England attach much importance to methods of refining sugar by electricity, but here the project has been brought up again in tangible shape, and the Electric Sugar Refining Company is reported to be getting a factory ready in Brooklyn, where it will use the Friend electric process, whatever that may be. The capital stock of this company is £200,000, held, so the story goes, to some extent in Liverpool, by persons interested in the sugar industry. We are told that this remarkable system will knock beet sugar into a cocked hat, and that it will refine a ton of the worst raw sugar that the West Indies or Java can produce into perfectly hard white sugar. A ton of raw material can be thus converted in two hours at a cost of 80 cents a ton, and this company is reported to be getting ready to turn out 3,000 barrels of crystallised sugar a day. The project is viewed with a great deal of scepticism, but if sewage can be refined, why not sugar?

The cable steamer "Minia," which has been in dry dock so long here repairing after damage in the North Atlantic, has taken her departure for Halifax. It is understood that she will be actively engaged on important grappling work early in April. The visit of the steamer to New York has been quite a pleasant episode, and Captain Trott and his officers have left an extremely favourable impression behind them in electrical and other circles. Captain Trott's opinions on all subjects connected with navigation, as with cable laying, are of the utmost value; and I understand that while he was here he was consulted by some of the leading shipowners and their representatives as to the best course for steamers to take between England and America. Whatever advice he gave is sure to be followed. I understand that one very pleasant afternoon was spent by him at Mr. Edison's new laboratory, where he and the distinguished inventor exchanged their views on the subject of insulation for wires and cables. Captain Trott also, while here, paid considerable attention in leisure moments to the subject of electric traction, riding on the storage cars, and taking the opportunity to visit the Jamaica Long Island Electric Railway.

CORRESPONDENCE.

THE POST OFFICE AND THE TELEPHONE COMPANIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In course of your very interesting article last week on "The Postmaster-General and the Telephones" there has crept in one or two material inaccuracies, which I trust you will allow me to correct.

Speaking upon the question of whether there is or is not

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"competition" between the Government Department and the private companies, you say :—

"As a matter of fact, there is no competition between the parties. . . . . On the part of the Post Office there is virtually no competition at all, and, except in one or two isolated places, the department has had no opportunity of showing the public what the telephone is capable of if taken in hand solely in the public interest and not as a commercial speculation.

"Obviously the State can never risk public money by competition, in the ordinary business sense of the term ; and in this particular case the Post Office was utterly disabled from doing so by the fact that it accepted a royalty on the business of all its possible competitors. To take the royalty and try to acquire the earnings would have been in the highest degree unfair, and the result has been that the companies have had a free hand, hampered only by the condition that, for depriving the Post Office of what the law had declared to be its legitimate business, a portion of their receipts should be handed over to the public revenue."

1. Now, there can be no doubt as to the existence of competition between the Government and the telephone companies. The Post Office competes keenly for private line business, and also competes in *trunk wire* business, as for instance between Manchester and Liverpool.

In their turn, the private companies—by means of their trunk wires—compete in a rapidly increasing degree with the Postal Telegraphs.

In my company's district alone more than 50 per cent. of our subscribers make regular use of the inter-town system of communication, and the average number of trunk wire messages reaches 3,000 per day, as against 25,000 purely local. When estimating the monetary value of these telephone messages, it would be far wide of the mark to consider them as just so many sixpenny telegrams lost.

The telephone message is not limited, like the telegram, to a dozen words for sixpence. Three minutes' conversation is allowed, which, practically, is equivalent to a long telegram with a prepaid reply.

2. The telephone companies have *not* got a "free hand." How can they have when, in addition to paying their Government rival a "bounty" of 10 per cent. upon gross "exchange" receipts, that rival is empowered to dictate what shall or shall not constitute legitimate telephone business ? To take only one instance, my company has for a very long time been desirous of adopting a message system, as existing in the United States, but the Postmaster-General steps in and, in his license, vetos our power to traffic in "written messages." So far is this prohibition carried, that the department complained strongly at the last General Election of our transmitting results of the poll from one town to another, although such results, once made public in any town, became common property.

There are several interesting points for discussion that occur to me in connection with this topic, but I fear I have already trespassed unduly on your space.—Yours, &c.,

KENNETH MACIVER, Sec. and Gen. Manager.

Lancashire and Cheshire Telephonic Exchange Company (Limited),

38, Faulkner-street, Manchester, Feb. 8th, 1888.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I agree with your opinion expressed in your leading article, that it is somewhat rash to infer telephone companies' shares will gain by our Post Office acting on the line of policy indicated by the Postmaster-General's speech.

Suppose negotiations should be entered into for this purpose, the question will arise, What have the telephone companies to sell ?

Firstly. Two master patents, which will expire in two or three years.

Secondly. Telephone exchanges in all the principal towns, including plant lines, way-leaves, and probably goodwill of same ; also some long-distance trunk lines between towns.

Thirdly. Concessions given by the Postmaster-General which have to run for about thirty years ; but as the concessions are not exclusive, I take it their value, especially to him who has granted them, cannot be very great.

Fourthly. Commercial goodwill. The telephone companies have not fostered the establishment of a trade, either manufacturing or commercial, in the United Kingdom ; on the contrary, their policy has been decidly in the opposite direction. Such a goodwill, therefore, can hardly exist.

Fifthly. The chances of the Bell-Edison patents being renewed. Mr. Moseley tells us that the telephone companies indulge in some hope that their rights will be renewed. If they should apply for renewal, it is very certain that they will encounter determined resistance from the public, to whom they have shown few favours ; and from the electrical trade, whom they have treated in a spirit of unaccountable shortsightedness, which will be apparent to them whenever the time comes.

It appears to me, therefore, that the telephone companies have to offer nothing but patent rights for a very short period and the plant, &c., of their exchanges.

Now, the capital of all the companies (taken from a book edited by Mr. Fitzgerald) is about two and a-half millions sterling, the market value being (quoting the same author) five millions sterling. Sir, do you think the Government—that is the public—can be induced to give that sum for what the companies have to offer ?

I think the subject is one of paramount importance to the electrical trade, and I hope that when it reaches the stage of practical politics, you will lend your powerful aid to obtain a thorough discussion, and then with your permission I will again address you.—Yours, &c., JUSTICE.

February 8, 1888.

THE FALSE ZERO METHOD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : In your issue of the 3rd instant M. Emile Lacoine draws attention to the fact that in using the false zero method in cable testing it is quite unnecessary to keep the resistance of the battery circuit constant.

The truth of this fact, as well as that of the general law of Dr. Frölich, can be very simply shown in the following way :—

Let P R T be a wire through which a current, C, is flowing. The difference of potential between the two points Q and S will be $C r$, if the resistance of the wire from Q to S is r, and if there is no electromotive force between the two points. If, however, between Q and S there be an electromotive force E the difference of potential will be

$$C r - E,$$

and this difference of potential will be zero if we choose the points Q and S so that $C r = E$.

But if Q and S are at the same potential we may join them by a wire without altering the current flowing either in the wire P R T or in any other wire with which it is connected. Moreover, this will be true whatever be the resistance of the wire used to connect Q with S. In particular it will be true even if this wire has no resistance at all. In this case we practically cut out the battery and the resistance r from the rest of the circuit, without changing any current by the process. This means that if we alter the resistance of any conductor, and at the same time insert an electromotive force, the current in that conductor, or that in any other conductor connected with it, will remain exactly the same as before, provided the electromotive force added is equal to that required to maintain the current (formerly flowing through that conductor) through the additional resistance inserted.

A more elaborate proof of this statement will be found given in a paper by me in the *Proceedings* of the Society of Telegraph-Engineers for May, 1887, and reprinted in *The Electrician*, June to July, 1887. Dr. Frölich's general theorem is an immediate consequence.

For if in any network of conductors, such as the Wheatstone bridge, the resistances of the different branches are so arranged that the current flowing in one branch g is un-

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altered by the insertion of an electromotive force into a second branch b, then the current in the branch g will be unaltered by changing the resistance of the branch b, whether there are other electromotive forces acting in some of the other branches or not. For if we alter the resistance of the branch b by any given amount, we can always find a corresponding electromotive force which, when inserted in the branch b, will produce the same effect in the branch g. If the current in g is independent

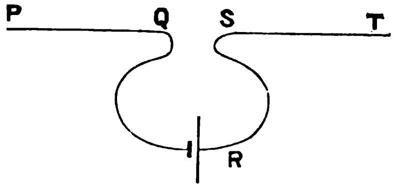

Fig. 1.

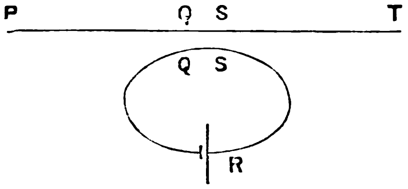

Fig. 2.

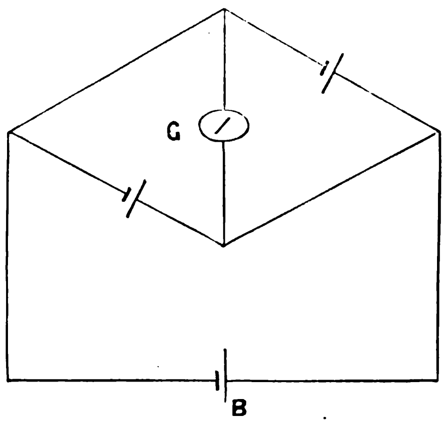

Fig. 3.

of the change of electromotive force in b, it must also be independent of the change of resistance, however great this may be. If, therefore, the current in g is independent of the electromotive force in b, it must be the same whether the battery circuit be open or closed.—Yours, &c.,

W. E. Sumpner.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: On p. 316 of the present volume is a reprint from the *Journal Télégraphique* of an article on the False Zero Method, in which M. Emile Lacoine points out that it is unnecessary to know the value of the resistance of the battery employed in making the test. That this resistance need not be known was shown by the writer in the *Electrical Review* in 1885 (p. 392, Vol. XVII.), and a proof identical with M. Lacoine's was given.—Yours, &c., E. C. Rimington.

[Our correspondent encloses another demonstration obtained by the use of Maxwell's method of cyclic signs.—Ed. *E.*]

SPRINGS ON OVERHEAD WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Preece appears to overlook the fact that his published Table of Dips and Stresses demonstrates how oblivious he is to the powerful influence of elasticity on the line wires; and his mistake about the effect of springs arises in the same way. I endeavoured to show this in my *unanswered* letters, *The Electrician*, November 4th and December 9th, 1887.

If Mr. Bozon seriously proposes to make less than 1½lb. of india rubber per span compensate the wire at the rate of 4in. yield per ½-cwt. stress, I think he will find he is attempting the impossible. And till he succeeds in this particular further discussion of the remaining features of his invention may stand over.

My springs, which are of No. 8 gauge, are dipped hot in a boiling composition, which renders them about as weather-proof as No. 8 galvanised iron wire.

The value of spring shackles would be specially realised on wilderness lines, such as cross great tracts in Australia and Canada, where the delays of breakdowns and costs of repairs are exceptionally heavy.—Yours, &c., Frank Caws.

Sunderland, February 4th, 1888.

[It is a little amusing to find Mr. Caws instructing Mr. Preece upon the proper method of erecting telegraph wires. Mr. Preece, we take it, has implicitly asserted that the modulus of elasticity may for practical purposes be neglected in calculating the dip of an overhead wire; Mr. Caws asserts the contrary. Mr. Preece also thinks that the service will continue to be carried on efficiently without the aid of Mr. Caws's spring shackles. Our correspondent ventures to differ.—Ed. *E.*]

THE DEFINITION OF THE COEFFICIENT OF SELF-INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In Dr. Fleming's article on "Alternate Currents," p. 315, the electro-magnetic energy of the circuit is expressed by $\frac{1}{2}L i^2$. The expression given in Cumming's "Theory of Electricity," p. 206, is $L i^2$. May I ask if L is different as used in Cumming from its definition in Dr. Fleming's article?—Yours, &c., G. B.

THE EFFECT OF MAGNETISATION ON THE THERMO-ELECTRICAL PROPERTIES OF BISMUTH.

A CORRECTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Will you kindly correct a slight inaccuracy in the report in *The Electrician* of my paper on the effect of magnetisation on the thermo-electrical properties of bismuth?

Instead of ·0022 microvolt per 1° C., write ·0022 microvolt per unit magnetising force, the temperature of the two junctions being 100° C. and 16° C.—Yours, &c.,

Herbert Tomlinson.

King's College, Strand, February 7th.

BATTERY CARBONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Can any of your readers inform me what is the relative value and durability of battery carbon plates sawn from the block, and "compressed" carbons? I have an impression that the latter, while being less porous, and more equal in density, are subject to disintegration under the influence of acids.—Yours, &c., Carbo.

TECHNICAL CONFERENCE AT THE ROYAL VICTORIA HALL.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In consequence of the great interest shown in the Conference on Technical Education held here on December 14th, we have arranged another for the 15th inst., at 8 p.m., and Captain Sir Douglas Galton, K.C.B., has kindly consented

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to take the chair. At the first meeting a resolution in favour of technical education was carried unanimously, and now the subject for discussion is, What is the best way of obtaining it? As before, it is hoped that politics will be avoided, since this is not a party question, but concerns Liberals and Conservatives, employers and workmen equally. All seats will be free, but intending speakers should send in their names to me here *before* the day of meeting. So many expressed a wish to speak during the last meeting that it was impossible to hear all, and it has been thought best to hear those (so far as time will permit) who give notice not later than the previous day. Will you kindly make room for the above particulars in your columns, and oblige,—Yours, &c.,

EMMA CONS,
Hon. Sec. and Trustee.

Waterloo Bridge-road, S.E.,
February, 1888.

LEGAL INTELLIGENCE.

Gaulard and others v. Sir Coutts Lindsay and Co. and Ferranti.

This was an appeal from a decision of Mr. Justice Kekewich. The action was brought by Messrs. L. Gaulard and J. D. Gibbs and the National Company for the Distribution of Electricity by Secondary Generators (Limited) against Sir Coutts Lindsay and Co. (Limited) and Sebastian Ziani de Ferranti to restrain the infringement of five letters patent of the plaintiffs. On the 21st of November Mr. Justice Kekewich, in the matter of a petition presented by Ferranti for revocation of one of the patents, made an order giving the plaintiffs liberty to apply at the Patent Office to amend the specification of that one of the letters patent. The plaintiffs afterwards moved for liberty to apply at the Patent Office to amend the same specification by way of disclaimer, correction, or explanation, and that in the meantime the trial of this action might be postponed, and that the specification, when amended, might be used in evidence at the trial on such terms as the Court might think fit. The application was made under Section 19 of the Patents, Designs, and Trade Marks Act, 1883, which provides that "in an action for an infringement of a patent, and in a proceeding for revocation of a patent, the Court or Judge may at any time order that the patentee shall, subject to such terms as to costs and otherwise as the Court or Judge may impose, be at liberty to apply at the Patent Office for leave to amend his specification by way of disclaimer, and may direct that in the meantime the trial or hearing of the action shall be postponed." Mr. Justice Kekewich was of opinion that it would be unreasonable to allow a postponement of the action as to all the patents. And he said that if the plaintiffs would not accept the defendants' offer, that the plaintiffs should discontinue the action as to the one patent and pay the costs as to that, the motion must be refused with costs. These terms being refused by the applicants' counsel, the motion was accordingly refused with costs. The plaintiffs appealed.

Before the conclusion of the arguments the plaintiffs consented to the order which they asked being made upon the following terms (which the defendants were willing to accept):—That the plaintiffs should pay all the costs of the action up to the present time, and that they should not claim any relief in respect of anything done by the defendants before the amendment of the specification. The defendants to have liberty to amend their defence and particulars of objection.

Lord Justice COTTON said that a long and learned argument had taken place upon the construction of Section 19; but, as both parties had assented to terms, he would give his judgment very shortly. In the case of "Bray v. Gardner" Mr. Justice Stirling had given liberty to the plaintiffs to apply for leave to amend their specification on the terms that the amended specification should not be used in the pending action. The Court of Appeal said that liberty to make such an application ought not to be given under Section 19, unless it could be given without injustice to the defendant. But the Court did not say that the terms then imposed ought to be imposed in every case. In the present case Mr. Justice Kekewich thought the other terms should be imposed. But the appellants had now offered terms which his Lordship thought would do complete justice in the present case. This offer had not been made in the Court below. As the plaintiffs were asking for an indulgence, they must pay the costs of this application in both courts.

Lord Justice LINDLEY agreed. He did not think there was any difference between "Bray *v.* Gardner" and "Allen *v.* Doulton." In every case the Court must see what would be right and just.

Lord Justice BOWEN also concurred. He desired to point out that what had been said by Lord Justice Cotton in no way narrowed the construction of the Act. When an Act of Parliament had vested a discretion in the Court, the Court never wished to limit that discretion by laying down rules as to the way in which it was to be exercised. The discretion was given to the Court. The language of Section 19 appeared to indicate that terms were to be imposed by the Court, if it should think the justice of the case required that they should be—that is, in order to prevent injustice being done to the one party by the indulgence which was granted to the other. That was exactly what was laid down in "Bray *v.* Gardner."

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

1,243. H. LUCAS and E. D. VAUGHTON. Birmingham. An improved portable electric lamp. January 27, 1888.

1,250. M. IMMISCH. London. An improved water-wheel for driving electric generators and its combination with, or application to, such generators. January 27, 1888.

1,254. J. SPINK and C. GAUZENTES. Bradford. Improvements in forming metallic connections with incandescent lamps and holders therefor. January 27, 1888.

1,364. F. J. MARTIN. London. Electric lighting for railway and other carriages. January 30, 1888.

1,383. F. BOREL and E. PACCAUD. London. Electric apparatus for use either as an electro-motor or as an electric current meter. January 30, 1888.

1,386. G. FOWLER. Peckham. Improvements in telegraph insulators and appliances for suspending wires on aerial telegraphs. January 30, 1888.

1,406. M. TURTON and S. TURTON. Tipton. Improvements to and in connection with electric time signals or alarums. January 31, 1888.

1,461. R. K. BOYLE. London. Improvements in applying metals to metals by electric action or electric fusion, applicable more especially to obtaining a rough hard surface or a surface of a character other than that of the metal to which the said surface is applied, but applicable in other cases where metals can be joined to metals by electric action or electric fusion. January 31, 1888.

1,505. M. McMULLIN. London. Improvements in the construction of electric brushes for curative purposes. February 1, 1888.

1,525. L. E. SOLIGNAC. London. Improvements relating to the distribution of electricity. February 1, 1888.

1,536. J. BATTYE. Batley. Magnetic and electric telephone and telegraph for transmitting and receiving musical vibrations or signals by means of electricity. February 2, 1888.

1,557. F. JACOB. London. Improvements in the duplex telegraphy. February 2, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

February 4, 1888.

3,658. R. DICK and R. KENNEDY. Glasgow. Improvements in alternating current transformers or induction coils. March 10, 1887.

3,767. J. LEA. London. A method of checking or arresting the feed of an arc lamp and appliances for the purpose. March 12, 1887.

4,070. M. H. P. R. SANKEY and P. W. WILLANS. London. Improvements in combined engines and dynamos. March 17, 1887.

4,781. THE ELECTRICAL POWER STORAGE COMPANY (Limited) and H. W. BUTLER. London. Improvements in electric batteries. March 30, 1887.

4,809. E. TORTORA. London. Improvements in insulating electric conductors. March 31, 1887.

17,837. P. M. JUSTICE. London. Improved means of generating electricity from heat (E. G. Acheson, United States). December 28, 1887.

17,888. G. A. SMITH. London. Improvements in and relating to electro-magnetic marine governors. December 29, 1887.

17,965. F. REDMOND. Dublin. Improved machines for cleaning windows, mirrors, and similar articles, by either mechanical or electrical power. December 31, 1887.

PATENTS SEALED.

January 27, 1888.

1,738. C. D. ABEL. London. Improvements in dynamo-electric machines (Siemens and Halske, Germany). February 3, 1887.

13,091. M. VIAU. Bilbao, Spain. Electric motor for clocks and for industrial purposes requiring small power. September 27, 1887.

January 31, 1888.

275. R. E. B. CROMPTON and J. F. H. SOLL. Chelmsford. Improvements in and apparatus for effecting the distribution of currents of electricity. January 7, 1887.

1,331. D. HALPIN and J. A. TIMMIS. London. Improvements in commutator brushes or contact pieces for electrical apparatus. January 27, 1887.

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SPECIFICATIONS PUBLISHED DURING THE WEEK.

1,904, 1887.—G. KAPP and others. Transformers. (Price 8d.)
2,130, 1887.—F. JEHL. Electrical inductors, &c. (Price 8d.)
3,560, 1887.—E. C. WARBURTON. Electric lamps. (Price 8d.)
3,611, 1887.—G. FORBES. Laying electrical conductors underground. (Price 8d.)
3,782, 1887.—E. EDWARDS (Kunhardt). Electro telegraphs. (Price 8d.)
3,785, 1887.—E. W. BECKINGSALE. Junction and testing boxes for electrical conductors. (Price 6d.)
9,725, 1887.—W. P. THOMPSON (Westinghouse). Dynamo electric machines. (Price 8d.)
14,260, 1887.—S. C. DREW. Preventing induction in telephonic circuits. (Price 6d.)
15,588, 1887.—J. Y. JOHNSON (Rechniewski). Dynamo electric machines. (Price 6d.)
16,588, A. WRIGHT. Measuring, &c., electric currents. (Price 6d.)

COMPANIES' MEETINGS.

Anglo-American Telegraph Company (Limited).

The Right Hon. Viscount Monck presided at Winchester House, Old Broad-street, over the half-yearly general meeting of this Company, which was held on the 3rd inst.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the minutes of the last meeting, and the report of the Directors was taken as read.

The CHAIRMAN: It is now my duty to move the adoption of the report, and in doing so to give you a short epitome of the history of the Company for the last six months. The first observation I shall make is that during the past six months we have carried a very large increase of traffic, as you will see by referring to the report; but I regret to say that it is not satisfactory in one sense—that it has not yet become remunerative. With regard to the expenses there is very little to be said. You will find on referring to the statement that the expenses are pretty much what they were in the corresponding half of last year. There are one or two items that are in excess, but they may be accounted for by special circumstances. One is the expense of stationery at the stations, and that increase is caused by a very large supply sent out to Heart's Content, Newfoundland. Another item which is a little in excess is that of travelling, which was caused by moving clerks from station to station at the time the 1869 cable was not operating. There is also an item for lodging allowance, fuel, light, and provisions, which is in excess of last year. I am sorry to say that that is caused by our having to provide extra provisions for Newfoundland and the smaller stations, owing to the loss of a cargo by shipwreck. There is also an item of repairs and furniture, which exceeds that for last year, due to special repairs at the Heart's Content Station, amounting to £1,200. These are the only things which I refer to in the working expenses, but we have had a very considerable addition to our general expenses this half year by the repair of the 1869 cable, and also for transferring the shore ends of cables at Valentia Bay. The repair of the 1869 cable appears to me to be a most important circumstance—in fact, I think it almost marks an epoch in the history of telegraph construction and repairs. You must remember that the 1869 cable was laid down, as its name implies, in the year 1869, so that it was eighteen years under water when it was lifted. The breach was in 2,750 fathoms; but it was lifted in 2,300 fathoms. It was lifted by our own ship, and I do not think that we ought to discuss this matter without paying a tribute to the very great ability, energy, and skill exhibited by Captain Trott and the officers and crew of the steamship "Minia" (cheers). I think it is only fair that the meeting, in discussing this matter, should remember how much you owe to the intelligence and energy of those people. Well, gentlemen, we had also—not a repair exactly—but we had to transfer the shore ends of the cables at Valentia from their original positions, in which they were subject to abrasion from the roughness of the bottom on which they were laid, to another position, in which there was a sandy bottom, and in which they rest more easily, and with less risk of injury. Now, this 1869 cable has been several times under repair, and the other day I was talking to my friend, Mr. Weaver, about it, and I said, "It seems to me it must by this time be like the proverbial schoolboy's knife, which first had new blades in place of the old ones, and then a new handle, so that there was no part of the original knife left." Mr. Weaver, however, corrected me by having a diagram made, which I should very much like to exhibit to you, for I think it would be as interesting to you as it was to me. It is a diagram of the bottom of the Atlantic, showing the way in which this cable lies. The bottom of the Atlantic in its configuration is not very different from the surface of the earth. It has its valleys and hills, and its mountains and plains, and you will find, on looking at the diagram, that the injuries to the cable have been produced in only two or three places over the whole space between here and America, and that for a very large portion of the distance the cable has lain perfectly secure, because it lies on a soft and smooth bottom. Where it hangs down from mountains—and 2,750 fathoms means a very high mountain, indeed three miles high—where it hangs down from such places as that it is subject to constant injury, and it is in those places that the injuries have taken place. In the very long part which exists between those rough portions of the distance the cable is perfectly secure, and has for nearly nineteen years never been injured. I think, as far as Atlantic cables are concerned, there is some consolation in this matter, for it shows that if we only can get a good bottom we may calculate on a very long life for our cables. (The diagram was here placed on the wall and explained to the meeting.) The Chairman continued: I thought it would be interesting to you to show the exact position of the cable, and I asked Mr. Weaver to bring the diagram here. The faults were removed by Captain Trott, of the steamship "Minia," most effectually, and the traffic through the cable was restored. I am sorry to say, however—as you will see by the report—that it has given out in another position, somewhat in the same direction as the former one, but a little nearer to Europe. In addition to our contest with Nature, so to speak, at the bottom of the sea, we have had a contest with the French Company, as you are aware, in the law courts in Paris. They, as we contend, acted contrary to their agreement, and left what we call the pool of the associated companies, and attempted either to set up for themselves or to join our opponents. We brought our action against them for doing so, and we have succeeded so far that we have obtained a decree entirely in our favour, and until that decree is reversed we have a right to suppose that we are on the right side. An appeal has been notified and will take place in a short time, and until that appeal takes place of course we cannot consider ourselves out of difficulty, and we must wait until the decision of the Court on the subject is given. These are the matters which I call the history of the Company during the six months. I now come to what is a matter of much more importance, and that is the contest which is going on between us and the Commercial Cable Company. We have been accused of having what is called a fighting tariff. Now, I should like for one moment to refer back to the beginning of the contest to show that if there is any moral turpitude in instituting a fighting tariff we are not the parties who should be accused of the crime. I may say, at the same time, that the accusation sits very lightly on my shoulders. However, as a matter of fact, when the Commercial Company commenced their operations the tariff was 2s. a word. They reduced their tariff to 1s. 8d., and of course we were obliged to come to the same figure. We have not the same power over the public that the Commercial Company seem to have. We cannot get people to give 2s. for what they can buy for 1s. 8d., although the Commercial Company managed for some time to get 1s. for what the public could get from us for 6d. That was the state of things a year and a-half ago, and your Board, on considering with great care all the circumstances of the case, came to the conclusion that the only policy that we could adopt was to reduce the tariff, not for the purpose of fighting, but for the purpose of stimulating the traffic with the object of gaining a large revenue from a low tariff. That object was fully stated here by me at the time. It was accepted by the great body of the shareholders as a wise and proper policy to adopt, and I am still of the same opinion. At the same time, if you will remember, I carefully guarded myself against naming sixpence, or any sum, as the ultimate point at which the tariff should be fixed. I told you that we were engaged on an experiment; that our design was to attain two objects—one, to adopt a low tariff, to increase the traffic and stimulate consumption by means of the reduced price, and the other to ascertain what tariff would give us a fair revenue, and not so large a revenue as to encourage further competition. We stated, at the same time, that we would give the sixpenny tariff a fair and full trial; that we would make no alterations until we had ascertained how far the sixpenny tariff would answer the objects that we had in view. I told you at the time that the policy we had adopted, and which you approved, would make a considerable demand upon your patience and forbearance, and I ventured to predict also that it would largely increase the traffic over the cables. My vaticinations in both respects have been fulfilled—in one respect I am afraid absolutely; in the other, only partially. I am afraid your patience has been sorely tried, and I am sure no one in the world regrets the necessity for it more than my colleagues and myself. The other prophecy which I ventured to make—that the traffic would be largely increased—has also been fulfilled. You will see by the report that our traffic at present is 162 per cent. larger than it was before the sixpenny rate was adopted; but, unfortunately, that is not enough to give you a remunerative revenue. I think we have given the sixpenny tariff a very fair trial. For the first year the increase was very large, but for the last year it has been only 12 per cent. Although that 12 per cent. might, in a certain time, grow to a very much larger amount, I am afraid that the trial of your patience would be so great that it would reach what is called "the straining point," and that we should not be able to do it. I think we have tried the 6d. tariff to its full extent, and I do not think there is that element of increase in the traffic which promises to render it remunerative to the shareholders. But the question is—What are we to do? We have had meetings with representatives of the Commercial Cable Company, which have led to nothing except demands on their part to which it was impossible we could subscribe. My friend, Sir John Pender, at the Direct meeting the other day, threw out a hint that we ought to have a conference. Well, I can only say I am entirely at one with Sir John Pender, and so is our Board, that if anything can come out of a conference we are most anxious to hold it. We are quite willing to go into another conference, and to hear what is said by the other side, and to say what we have to say; but I confess that my experience of the past has not been such as to render me very sanguine as to the result of what the conference might bring. However, I am always willing to let hope triumph over experience, and if Sir John Pender can induce the other parties interested in the matter to come into a conference he will not find us holding back; and I may say, on the part of myself and colleagues, that we will go into a conference with perfectly unbiassed minds, and if it is held we are prepared to carry on any further experimental investigations as to the amount of tariff which may be proposed, and if any proposals are made which seem to us likely to lead to satisfactory and just conclusions they will not find the Anglo-American Company an obstacle to their adoption. Gentlemen, with these observations, I beg leave to move:

"*That the report of the Directors and accompanying statement of accounts*

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"to 31st December, 1887, submitted to this meeting, be and the same are "hereby received and adopted." (Applause.)

The Most Hon. the Marquis of TWEEDDALE seconded the motion.

Mr. THOS. SMITH (York) supported the adoption of the report, which he thought was a moderately satisfactory one, showing an increase of 162 per cent. of traffic compared with the same period of 1885, and over 1886 of 12 per cent. That had enabled the Directors to pay 10s. per cent. on the ordinary stock and 20s. per cent. on the preferred shares for the last quarter, and to carry forward a balance of £2,344. For the same quarter of 1886 there was no dividend, and no balance was carried forward. Therefore, he considered the present report so far satisfactory that they were enabled to pay the dividend mentioned. The sixpenny tariff had now had a fair trial, having been in operation nearly two years. They could not, therefore, reasonably expect after the experience they had had that there would be a much larger increase. There might be a little better traffic or a little worse, but to his mind the sixpenny rate was now about played out. The question therefore which the shareholders had to face was whether the dividend at the present rate of 2 per cent. per annum—supposing they were able to continue it, and he thought they would—was a sufficiently remunerative one to satisfy the shareholders. Without wishing in any way to hamper the Directors, he would suggest that now was a time to consider and settle a further reduction of the rates. That was the policy which he had advocated from the commencement. He was still of the same opinion as before, and he thought it was worth the attention of the Board, though he did not wish to tie the Board to any decision. In paragraph No. 7, it is notified that the Western Union Company since the last meeting had opened negotiations with the Commercial Company for an amicable settlement. He was sorry to say that the Commercial Company's demands were of such a nature as to prevent any agreement being arrived at, and they threatened that unless their terms were agreed to they would immediately adopt a 6d. rate. They had been previously charging 1s. He was pleased to say that that threat had had no effect on the Directors. It was no use trying to hide the truth from themselves—that both companies fully understood that they were engaged in a war in which one must give way. It was pretty well known that the Commercial Company at the present time were making no dividend, if even they were paying their expenses. The Anglo shareholders had submitted for some time very patiently to receive very small dividends. He thought they might reasonably say that they had now come to a crisis in their affairs, and that one party must give way. They must have war, and they must face it as a war, and he thought that a 3d. rate would terminate that war. There was no doubt that the Commercial Company had used the French cable as a very strong weapon against the Anglo Company. He thought the Directors should carry out the policy which they had been compelled to adopt in sheer self-defence to its logical conclusion. The Company formerly charged 2s. a word; the Commercial Company reduced theirs to 1s. 8d., and he believed that that company had some other policy which the Anglo shareholders were not aware of. It was no use burking matters. Some shareholders would say: "Let us have peace—peace at any price. We want a 1s. or 1s. 6d. rate. Never mind other parties; let us attend to our own affairs." He held, however, that if they adopted such a policy as that they would eventually be in a worse position than they were in now. While referring to the action of their opponents he congratulated the Board on the victory which they had gained over the French Company in the law suit. He thought they ought to congratulate the Directors, and especially the solicitor, on the manner in which the agreement was drawn up between the Company and the French Company. If it had not been well done, and done in a lawyer-like manner, probably the agreement would have been evaded. He believed the Directors would continue to carry their point. Paragraph 4 of the Directors' report was worthy of the shareholders' attention, for he believed that it marked great progress in the power of effecting repairs in cables at almost any depth. That fact meant that they would need no further increase to their renewal fund. He thought that that fund was now shown in such a way that it must be satisfactory to the shareholders. It showed at a glance the par value of the investments, the cost and the annual interest from each investment. The market value that day of their renewal fund was only £6,000 short of one million. He thought that was a very favourable item in their balance-sheet. The whole amount invested just returned an average of 3½ per cent., which in these times indicated a splendid investment, especially where they had security, as was their case. Their financial position was therefore a strong and sound one.

Mr. CHESTER said he noticed that their dividend that day entirely depended on an estimated balance brought forward. The auditors in auditing the accounts had carefully taken a position in which their audit was based upon that estimated balance being correct. He would be glad if the Directors could throw a little light on those estimates now. With respect to the lawsuit just concluded, he would also wish to ask whether the company which appealed against the decision that had been given had not questioned the validity of the Court which had given the decree lately received by the Company. With regard to the 6d. rate, he was rather surprised to hear a gentleman advocating such a rate to-day. That rate was brought forward as a fighting rate. The Chairman told them so at the time.

The CHAIRMAN: No, no!

Mr. CHESTER said he would not contradict the noble Chairman. He, however, protested against it at the time. He did not wish to be guilty of egotism, but he thought he might say that the remarks which he made at the time had turned out literally true. He was very sorry to hear proposals made to reduce the rate to 3d. a word, and he would ask the shareholders to remember that they were now only travelling over the same proceedings which had marked the history of the Company for the last 15 years. He asked them had those proceedings ever resulted in any benefit to the shareholders? They tried to crush out opposition, and what had that led to but to other cables being laid? Did they think that they could say to the world that the traffic across the Atlantic was their own, and that they were determined to oppose every company tooth and nail that opposed them? If they said so he thought they formed a very wrong estimate of the rest of the world. They were just repeating what they had done before, and he asked them whether they would not have the same results as they had before? He would have been very much pleased to hear a proposal to come to some intermediate arrangement. He thought it would pay them better if the rate were raised to something like 9d. a word, which would pay the Company and meet the wants—the growing wants—of the community. A year or so back he told the shareholders that the gentleman who had just preceded him had represented the deferred shareholders to a great extent. He (the speaker) wished to ask the ordinary and the preferred shareholders what their interests were? They were the base of the Company. The deferred shareholders had only a right after the other shareholders were satisfied. He considered that they were in a grand position now with a fund of a million invested, which had been taken out of the pockets of the ordinary and preferred shareholders. A few years ago, when they were in a state of depression—he was glad they were getting out of that condition now—there were movements with a view of getting alterations in the Articles of Association, more especially with respect to the voting power. The deferred shareholders of the Company had equal voting power with the other shareholders. There was thus, on any question that might arise, £2,700,000 of voting power in the hands of those who he, maintained, were very little interested, and thus there was a power of swamping the shareholders with the votes of the deferred shareholders.

A SHAREHOLDER: The deferred shareholders have no voting power.

Mr. CHESTER said he believed his statement to be correct.

Mr. WOOD said he had been thinking whether they could not adopt another policy as regarded the rates—whether they could not have two classes of rates: one a 9d. rate for express messages, and another a 6d. rate for ordinary messages, so that those who required their messages to go instanter would have to pay an extra 3d. a word, and those who were not particular to an hour or two would pay a 6d. rate, and their messages would be transmitted in a short time. He thought it would be a mistake to alter the 6d. rate otherwise. The public did not like the constant chopping and changing of the rates. There was great irritation in the public mind against the Company. He thought it would be a good thing of them to maintain the 6d. rate, for he was sure that it would be the rate of the future. If the course he had suggested could be adopted they would possibly tide over the present crisis, and as the traffic was growing—last half-year it increased 12 per cent.—and as trade improved, of which there were signs on all sides, they would have a further increase of traffic, and they would find in the end that the 6d. rate was paying them.

Mr. JOHN NEWTON said that he did not exactly understand the speech of Mr. Chester. It seemed to the speaker that there had been nothing but a "squaring" of the opponents of the Company, and that as frequently as they compromised with their opponents they would bring about another competing cable. Any arrangement they made with their competitors would be subject, he should say, to some kind of "pool," and once they had a pool between England and America the monopoly to which reference had been made was created at once; and they could not avoid a monopoly, do what they would, in the carrying of messages between the two countries. It was inevitable. He disagreed from the Chairman about the present not being a fighting rate. There was no doubt that it was a fighting rate. They could not help themselves; they must fight with their competitors. The Bennett cable was a competing cable, and therefore the rate now in force was a fighting rate. He hoped that when an arrangement was made with the Bennett people it would be on the Anglo Company's own terms. When the original French Company had to be dealt with there was the "squaring" process. Then the Direct cable was started because its makers knew that the Company would buy them up, and they did so (No, no). Well, they were "squared." Then, when that was done, the cable contractors said: "Here is a market for another cable and we will lay it, and other companies will then come forward." As the result of that the French Company had to be taken into the "pool." It was inevitable that they would come to some arrangement with the Commercial Company, and then the telegraph engineers would lay another cable, and they would have to buy that unless they adopted the policy of downright fighting rates and buy the new cables that were laid at less than they cost the original makers. When they had beaten such opposition they could charge a rate that would be commercially sound, not one to pay handsome profits to the shareholders, though he did not say that they were not entitled to a good return. He maintained that there was no enterprise that more deserved a continual permanent 10 per cent. dividend, considering the grand work which they had done, but until they had thoroughly beaten their opponents by buying up the cables at less than they cost the contractors, they would have cables laid. In these days of commercial enterprise, if a market could only be found for goods, the goods would be produced, and a market had been found for the goods produced by cable-laying companies.

Mr. JACKSON said he rose not to oppose the report, but as a shareholder to complain, and he thought the circumstances justified complaint. The shareholders' patience had been exhausted. Certainly his had. He did not think the meeting was acquainted, notwithstanding what Mr. Smith and Mr. Newton had said, with what had been the cost in the last two years in money of the war of rates. The result to the shareholders had been that for the last two years—which some speakers seemed to regard as satisfactory—they had had a return on their capital of 16s. 3d. per cent. per annum. After twenty-two years' management of the Company by the most experienced men, and men of the highest position in the commercial world, he maintained that that was a result which justified great

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impatience, and was one which the shareholders should not tamely sit under. He did not think any shareholder in the Company would say that for the splendid services rendered by the Atlantic telegraph cables a 5 per cent. dividend was an excessive one. Mr. Newton had said that they ought to have a 10 per cent. guarantee. For his own part he held that 5 per cent. was not an excessive, but was only a moderate, return, though it should be considered a satisfactory one. Such a return as that in the last two years would have put into the shareholders' pockets £500,000 more. Were the shareholders satisfied with what they had received? If so, he had nothing further to say; but he was not satisfied. He considered it a most miserable result. If they had put their money into the funds they could have taken it out at a premium, whereas, having put their money into this Company, if they sold they would have to take 60 per cent. discount. The Chairman had told them that he was perfectly prepared to go into a conference to see what could be arranged, and no doubt shareholders could thoroughly trust themselves in a conference in the hands of their Chairman, Sir John Pender, and other gentlemen. They would be perfectly safe in the hands of those gentlemen, and they would find that their interests would be most thoroughly safeguarded. He thought that that was the most satisfactory announcement which had been made by his lordship. The shareholders knew what a war of rates was. Mr. Newton had told them that in this centre of commercial civilisation they must have a monopoly in their business, but he (Mr. Jackson) considered such an idea as that absurd. The bottom of the Atlantic was no man's territory. It was infatuation to demand what Mr. Newton had asked for. Mr. Newton had said that they must crush opposition. Did they think they could crush Mr. Mackay? As the result of the policy which they had adopted, the return which they had had for the last half-year had been only ⅞ per cent. He thanked the Board for one thing—their renewal fund; but looking at the return which the shareholders had received, he maintained that it was a humiliating position for the Company to be in after 22 years' working. He had been glad to hear the remarks that had been made respecting Captain Trott, whose repair of the 1869 cable would put more backbone into the position of the Company than anything else. The work performed by Capt. Trott had raised the value of Atlantic Cable property considerably, showing as it did that they did not want such an enormous renewal fund as was possessed by the Company. In the beggarly position of the Company, with their ⅞ per cent. return, he dare not propose any pecuniary reward to Capt. Trott, but he would propose that a hearty vote of thanks should be awarded to that gentleman.

Mr. Newton desired to explain that he had not in anything he had said assumed that they could crush Mr. Mackay. That gentleman was a man of business, and he asked the Directors to deal with him from that point of view. As to crushing him they could not do so.

Mr. Humphries thought the Chairman had placed before the shareholders the position of the Company in too roseate a colour. He found that instead of their having made any dividend last year they had a deficiency of £5,400. If they had had no reserve fund there would have been no dividend at all, seeing that their expenses last half-year exceeded the receipts by the amount he had mentioned. He thought that ought to convince the Directors that instead of a fighting policy they ought to try a policy of conciliation with their opponents, who were, perhaps, as much determined to fight as the Company were. For two years they had been going on at a continual loss, and he now thought they should try conciliation. He was not in favour of advancing the rates too high. They had tried a 6d. rate, which did not pay; let them now try 8d., 10d., or 1s., or such a rate as would not induce parties to lay another cable. With regard to the remarks which had been made about the deferred shareholders, he thought those holders ought to be considered. He supported the idea of the conference.

Mr. Seely said that within his recollection the Brest-St. Pierre cable had been repaired a great many times—at least six or seven times within the last seven years. If that were the case would the Chairman kindly inform them what the actual cost had been during the last seven years of those repairs, because if they were to go on repairing the cable it would be like what the Chairman had referred to as to the schoolboy's knife, and it might be more economical to have a new cable entirely, instead of going on making repairs. As to the policy of continuing the 6d. rate, he endorsed what the Chairman had said about being willing to go into some conference with their opponents. He thought the time had arrived when the 6d. war rate should end, for the small dividend which they had been receiving for the last two years was, as Mr. Jackson had said, deplorable.

A Stockholder desired to have an explanation of the item of £1,078 for repairs, furniture, &c., in the expenses at stations.

The Chairman said that probably he had not expressed himself clearly before. There were special repairs at Heart's Content station last year which took the sum of £1,200 out of the £1,780. That would not occur again.

A Shareholder observed that in paragraph 8 it was stated that the traffic in the past half-year showed an increase of 12 per cent. over that of the corresponding period of 1886. In the preceding paragraph it was stated that the Commercial Company had reduced their charge to 6d. He thought, in comparing the corresponding period with last half-year, they were not comparing the same things, for in the earlier period the Commercial Company were charging more than they were charging in the later period. He wished to know whether the increase from the 1st July to the 15th Sept. was at a greater rate than later on.

The Chairman: It is very difficult to answer that question. We have no means of knowing, except by estimating the proportions of traffic carried by the Commercial Company, and therefore it is very difficult indeed to arrive at a just and accurate conclusion as to the increase that has taken place between any two periods.

The Shareholder: I mean what was the increase of our traffic from the 1st July to 15th Sept.?

The Chairman: I could not answer the question offhand, but we could at the office, where you shall have the answer. Mr. Chester referred to the question of estimated balances. That phrase has been introduced, and necessarily introduced, into the report because our net balance will depend on the decision of the lawsuit in France. We have already had a decision in our favour which gives us a gross sum of about £30,000, or 2,000 francs a day for every day that the French Company adhere to their resolution to abandon the pool. But until that question is finally decided by the Court of Appeal everything we do must be mere estimate. Mr. Chester also asked me if the French Company were going to object to the competency of the Court that has already given this decision. I presume the French Company, if they are well advised, will take every objection they can to the decision; but I am not in their counsels. Mr. Burt, the solicitor, tells me that they did not raise that question in the tribunal before which we have gone. I cannot tell whether they will raise it now. I am very unwilling to trouble the meeting with what appears to be a mere personal question, but Mr. Chester insists that we adopted the 6d. rate as a fighting rate. Now I will read what I said in July, 1886, on the adoption of that rate. Having read extracts from the speech in question and from that which he delivered last year, he continued: I have thus kept this rate in every case distinct from the expression "a fighting rate." Mr. Wood suggested express messages. Mr. Wood cannot have a large experience of these meetings, or he would not have come forward with that suggestion as an original idea. I scarcely remember a meeting for the last ten or twelve years in which the same suggestion has not been made, and I have been obliged always to make the same answer—that the law will not allow us. Mr. Wood also said that there were continual choppings and changings of the rates. Well, all I can say is that we have had the 6d. rate in existence for nearly two years, and if we found it satisfactory we should not have the least wish to change it. The next observation I wish to make is with respect to what was said by Mr. Jackson, who expressed himself—and certainly his manner and tone entirely justified what he said—to the effect that he was thoroughly impatient; and indeed allow me to say that I am not in the least surprised at it. But, on the other hand, he may be impatient with the result without being impatient with the management of the Company. If you find that we are only fighting against facts which cannot be changed, and that we have done our best in dealing with these facts, I think that whatever your impatience may be with the results you should give us the credit of having done all that we could for you. Mr. Jackson, at the same time, did us the honour to call us men of experience and high character, and he also said that if we go into this conference, the shareholders will be quite safe in the hands of myself and Sir John Pender. I am very much obliged to Mr. Jackson for his good opinion of myself and Sir John Pender; but I think that it is inconsistent with what he has said as to the way in which we have managed your affairs. In point of fact, if the state of affairs is as humiliating as he says, he ought to turn us out. I do not think we deserve the character of experienced and good business men if this present state of things is due entirely to the Directors. I think we have done our best to meet facts which we could not control. Mr. Humphries said that if the repairs had been paid for out of revenue we could have paid no dividend. That is so; but the renewal fund was created for that very purpose, and it was by paying for the repairs out of renewal fund, which some gentlemen are very fond of clamouring against, that we were able to pay any dividend this time at all. Mr. Seely asked the cost of repairing the 1869 cable. That cable, as I said before, was not exactly in the condition I at first thought it was when I used the illustration about the schoolboy's knife. We have spent a great deal of money on that cable, but I cannot give you the figures of the cost offhand. Roughly, however, Mr. Weaver says, it has cost about £200,000, and is a long way short of a new cable. If it was for nothing else I think it is worth repairing and keeping it going as a test of how long a cable will last effectively in the Atlantic. It will have been down 20 years next year, and we have hopes and expectations that for a comparatively trifling cost we shall repair the present breach in it and it may remain intact for years to come. There is one consideration which we should not lose sight of, namely, that the other cables which have been laid down subsequently to this cable are of much better construction and likely to last much longer. He then put the resolution in the usual way, and declared it carried unanimously.

On the motion of the Chairman, seconded by the Marquis of Tweeddale, Sir Daniel Gooch, Bart., was re-elected a Director of the Company, as was also Mr. F. A. Bevan, on the motion of the Chairman, seconded by Sir James Anderson.

Mr. Davison then moved and Mr. Jackson seconded the re-election of the auditors, Mr. Joshua Dean and Mr. Francis Glass.

Mr. Jackson then proposed the following resolution:—

"*That the best thanks of this meeting of Anglo-American Telegraph stock-*" "*holders be given to Captain Trott and the officers and crew of the ss.*" "*'Minia' for their able and most successful services in repairing the*" "*Company's Brest-St. Pierre Cable in September last at the great depth*" "*of 2,300 fathoms.*"

He wished only to add with regard to the Chairman's observations respecting his (the speaker's) impatience, that the shareholders could judge only by results.

Mr. Stockdale seconded the motion.

The Chairman: I entirely concur in this resolution.

He then put it to the meeting, and it was carried *nem. con.*

Mr. Fry moved a vote of thanks to the Chairman and Directors, and expressed a hope that the Board would maintain a sixpenny tariff, in which case he believed that in the future they would have a very different tale to tell.

Mr. Smith seconded the motion, which was carried unanimously.

The Chairman: I am exceedingly obliged to you for your kind resolution. I have had the same demonstration of confidence so often that I

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find it difficult to discover a change of words to express my thanks. I am sure my colleagues entertain the same feeling.

The proceedings then terminated.

The Cuba Submarine Telegraph Company (Limited).

The thirty-third ordinary general meeting of this Company was held on Wednesday at the offices, 61, Old Broad-street, Mr. Joaquin de Mancha in the chair.

Mr. JAMES SCOTT (the Secretary) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said : The next thing that I have to propose is that the report and accounts now submitted be received and adopted. It is my good fortune again, gentlemen, to come before you with a very good return. I think we must congratulate ourselves upon the progress of the Company, and the success which the report we present you here so fully conveys to all who have taken the trouble to read it—I am afraid some of those present have not read it—but at all events the report and accounts are so clear that they do not require much explanation. You will see that our messages, compared with December, 1886, have increased in number 1,528, and in amount £1,523. The expenses are much about the same, although the repairs show an increase of about £300, which you will see from the report is in consequence of the harbour length having been worn out and replaced by Mr. Keith. There has been also a store built for putting in the spare cable which we have there, which Mr. Keith thought was necessary for the better preservation of the cable. You will see, gentlemen, that we are able to pay the half annual payment for the cable which we have contracted for, which amounts to £1,875 ; and, besides, we have in hand sufficient to pay to the preference shareholders the 10 per cent. to which they are entitled, and we also propose a dividend at the rate of 8 per cent. per annum upon the ordinary shares. I think that that is so satisfactory that it requires no comment. I have now to move that the report and accounts be received and adopted.

Mr. ALEXANDER F. LOW : I beg to second that.

The CHAIRMAN : If any gentleman wishes any explanation I shall be very happy to give it.

Mr. COCHRAN : I should just like to ask a question—how long the payment for the cable stands over ? It appears to me we are laying by an excessive amount. I have great faith in a reserve, but when you take into account we have £1,800 for this cable, that we have practically done all our repairs out of revenue, that we are laying aside this half year £3,000, it seems to me rathar an excessive amount. That is the policy the Directors are entitled to adopt and a safe policy, but it is a large sum in relation to the revenue which the shareholders are receiving. I notice there is a slight increase, if I am not mistaken, in the capital expenditure, which strikes one as a little singular, considering that the expenses are considerable, and that we are paying for repairs out of revenue.

Mr. M'LAREN SMITH : How is that cable getting on which you gave us rather an ominous account of at the last meeting ?

The CHAIRMAN : I think we have mentioned before, gentlemen, that we made a contract for this cable, for which we were to pay £48,000 ; instead of purchasing it at the time we made the contract to pay every year £3 750. We have paid up to now about £28,000, and there is still about £19,000 to pay, when the cable will become ours. We thought it was desirable at the time, and I think it has been a very good thing for the Company, instead of running the risk of buying a cable, and it perhaps not answering our purpose, to make the contract which we did. We have still five more years to pay, and the contractor agrees to keep a certain sum of money in our possession in case the cable requires to be put in repair. We have £5,000 for this purpose. Up to the present time it has worked most creditably to the Messrs. Hooper. At the time we were rather afraid it would not, but it has worked most satisfactorily, and we have great pleasure in being able to say so. With regard to the increase of capital, there has been, as I have already mentioned, an additional store built for the reception of spare cable; that cost £715 and has been charged to capital account. It is a good job done, and Mr. Keith said it was necessary we should do it. About the Batabano cable, I am sorry to say after the report was printed we had a telegram from Mr. Keith to say that the cable had not spoken. He had found out where the fault is, and he believes it will not be a very expensive job to repair it.

Mr. KEENLYSIDE : I really think you are piling up your reserves a little beyond the means of the Company. Would it not be possible to agree with Mr. Hooper to pay off the rest of his debt out of the reserve fund, instead of letting it go on for the next five years ? Could you not make some sort of bargain by which we should be in receipt of that revenue? It seems rather exorbitant to go on adding £6,500 to the reserve fund. It is 4 per cent. on the capital ; we are earning 12 per cent., and we are getting 8 per cent.

The CHAIRMAN : Half of the amount that we put to the reserve fund is from the interest produced by it, therefore it is not such a heavy charge as you think. It earns its own living, as you may say. As to the idea of paying for the cable, I like to have money to pay my debts, but I think it is better in my pocket than my creditors'. If I have a bill to pay three months hence I do not hasten to pay it until the money is due. The money is better in our hands than the contractor's, and, though we have no reason to believe that the cable will break, while we have the money in hand we have that extra security. If we pay for the cable at once that security wou'd be gone. We should have paid the money, and if the cable went wrong we would have to repair it ourselves. The moment the cable did not speak we should tell Mr. Hooper to go and repair it. We have £5,000 in hand for that ; we pay according to the contract that was made at the time, and I think it is for the benefit of the shareholders to continue the existing arrangement.

The motion for the adoption of the report and accounts was then put, and carried unanimously.

A dividend of 10 per cent. on the preference shares, subject to income-tax, was declared, and of 8 per cent., free of income-tax, on the ordinary shares, payable on and after the 9th inst.

Mr. HOOPER said the Government Store Department sent out a short time ago a cirular advertising short pieces of cable core that they had for disposal. These came into his hands, and proved to be some of the core his father supplied twenty years ago for the Indo-European Government. He had several pieces tested, and the insulation proved to be as good as at first. He was quite sure that it would be satisfactory to the shareholders to know that.

A vote of thanks to the Chairman and Directors then terminated the proceedings.

Submarine Telegraph Company.

Report of the Directors to be submitted at the meeting of the proprietors, to be held at the offices of the Company, 2, Throgmorton-avenue, London-wall, E.C., on Tuesday, the 14th inst., at 1 p.m.:—

The accounts for the six months ended 31st December, 1887, show a net result which enables the Directors to add the usual proportion of the receipts to the reserve fund, to recommend a dividend at the rate of 15½ per cent. per annum, and to carry over a balance of £209. 4s. 8½d. to the next account. The same dividend was paid in the corresponding period of 1886. In the six months of 1887 there were 27 pay-days instead of the usual number of 26, and therefore the item of salaries includes 27 payments, while the receipts, on the other hand, only include the takings of 26 weeks. This fact accounts for half the increase in the item of salaries as compared with 1886. The other half of the increase is due to the annual increment to the clerks' salaries. The drawback received from the insurance company at the expiration of the yearly policy in August, 1887, for the days the repairing ship was in port was £388. 16s., which is in excess of the usual half-yearly charge for insurance of steamer by £63. 6s. Consequently the item for insurance does not appear in the annexed accounts. The excess of £63. 6s. will be carried to the credit of the insurance account for the half year ending June, 1888.

All the Company's cables are at the present time in good working order, but the Norderney cable, belonging to the Government, is interrupted, and the engineer is engaged in repairing it. The number of messages transmitted in the six months was 1,695,360, against 1,691,280 in 1886, but the length of the messages was only 11·03 words against 11·11 words.

The Board has long been endeavouring to obtain a renewal of the French Concession, and on three occasions within the last two years they have had strong grounds for believing that those efforts would be crowned with success. Unfortunately, the English Government have changed their policy, and propose to take into their own hands at the expiration of the Company's French and Belgian Concessions in January, 1889, the working of telegraphic communication with Holland, Germany, Belgium and France. This change of policy was communicated to the Board in a letter addressed to the Chairman of the Company by the Chancellor of the Exchequer early in November, and the arrangements about to be concluded in Paris were thus frustrated. The Postmaster-General has since that time informed the Directors that Her Majesty's Government have decided not to grant any extension of the Company's license for landing cables on the shores of this country, or to sanction a continuance of the working arrangement between the Company and the Post Office, as defined by the agreement of 11th July, 1868, beyond the date fixed by that agreement. The Belgian Minister of Posts and Telegraphs has also informed the Directors that it has been decided not to renew the concession granted to the Company for landing cables on the Belgian shore. In these circumstances negotiations are being carried on between Her Majesty's Government and the Board, and when these negotiations are terminated, the result will be made known to the shareholders without delay.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 27th January amounted to £3,142, and for the week ended February 3rd to £2,730.

THE CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of January was 4,064, estimated to produce £3,300, against 3,957 messages, producing £3,218, in the corresponding month of last year. The traffic receipts for the month of October, estimated at £2,900, realised £3,024.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for January amounted to £1,943, and for the corresponding period in 1887 to £1,904.

EASTERN TELEGRAPH COMPANY.— The traffic receipts of this company for the month of January, 1888, amounted to £56,164, and to £53,435 in the corresponding period of 1887.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this company for January, 1888, amounted to £39,878, and for the corresponding period in 1887 to £39,331.

THE GREAT NORTHERN TELEGRAPH COMPANY.—The latest traffic receipts of this company are as follows:—Receipts in January, 1888, £21,400, against £20,400 in the corresponding month of 1887, and £19,880 in 1886.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.— The traffic receipts of this company for the week ended January 27th, 1888, after

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deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £1,764; and for the week ended February 3rd £1,562.

THE WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended 31st January, 1888, amount to £4,800.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated receipts of this company amounted to £3,209 for half month to 31st January, as compared with £2,831 last year. The October receipts, estimated at £5,371, realised £5,545.

PERSONAL.—We learn that Mr. A. C. Cockburn, who has been connected with the City and Guilds Technical College, Finsbury, since its foundation as Demonstrator in the Electrical Department, has resigned his appointment, having been appointed Manager to the Acme Electric Works, at 45, Tabernacle-street, Finsbury.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Feb. 8, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Feb. 8. Highest.	Lowest.
			TELEGRAPHS.					
£					£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	40 41	3 5 6	Jan., Apr., July, Oct.	41	40
2,614,820	Stock	20/0	Do. Preferred	66 67	3 19 9	,, ,,	67¼	66
2,614,820	Stock	nil.	Do. Deferred	14 15	...	February	14¾	14 1/16
130,000	£10	3/0	Brazilian Submarine	11¾ 12	5 16 8	Mar., June, Oct., Dec.	12⅛	11⅞
16,000	10	8/0	Cuba	12¾ 13¼	6 3 2	February and August	13 1/16	12 13/16
6,600	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	...	...
			Direct Spanish	3¾ 4¼			...	...
6,000	5	5/0	Do. Preference	8½ 9½	...	April and October ...	...	...
60,710	20	2/0	Direct United States Cable	8⅞ 9⅛	4 3 4	Jan., Apr., July, Oct.	9	8⅞
380,000	10	2/6	Eastern Telegraph	11¼ 11½	4 15 8	,, ,,	11 9/16	11 5/16
70,000	10	3/0	Do. 6 per Cent. Preference	14½ 14¾	4 1 4	,, ,,	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899 ....xd	106 109	3 19 6	February & August	107	...
250,000	10	2/6	Eastern Extension	12¼ 12½	4 15 8	Jan., Apr., July, Oct	12 7/16	12¼
22,050	10	5/9	German Union	8¾ 9¼	6 6 3	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust ....xd	5⅜ 5⅝	4 18 0	Jan., Apr., July, Oct.	5 9/16	5⅝
178,992	10	3/0	Do. 6 per Cent. Preference ....xd	13⅜ 13⅞	4 8 0	,, ,,	13 9/16	13⅜
150,000	10	5%	Great Northern	13¾ 14¼	5 5 6	Jan., July, and April	13⅞	...
17,000	25	5/0	Indo-European	38 40	6 5 0	April and October ...	...	...
			London Platino Brazilian	4¾ 5¼	6 10 0		4⅞	...
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October ...	...	...
338,225	Stock	12%	Submarine	140 150	9 6 8	February & August	...	...
30,000	10	6/0	West Coast of America	5 5½	4 11 3	January and July ...	5 7/16	...
			Do. Debentures	111 116	...		...	...
88,321	10	nil.	West India and Panama	¾ 1	...	—	...	...
34,563	10	9/0	Do. 1st Preference	9½ 10	7 10 0	April and October ...	9 13/16	9¾
45,181	15	3/9	Western Brazilian	9 9½	7 15 0	March & September	9⅜	8¾
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 104	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	9/16 11/16	5 9 0	Yearly	...	...
			Oriental	¼ ½	...		...	...
80,000	£5	5/0	United Telephone	12¾ 13¼	5 6 6	June and December	13⅛	12⅞
			United River Plate Telephone	4½ 5	5 5 3		5	...
			ELECTRIC LIGHT.					
	5		Anglo-American Brush (£4 paid)	3 3½	...		3¼	3 3/16
23,692	5	nil.	Do. (fully paid)	4 4½	...	February & August	4⅜	...
79,934	5	nil.	Swan United (£3. 10s. paid)	1⅝ 1⅞	...		1 13/16	1¾
312,000	¼	0/1½d. '86	Maxim-Weston	3/16 5/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction	38½ 39½	6 3 0	March and July	39½	38⅞
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	17 19	7 18 0	February & August	17 11/16	16⅞

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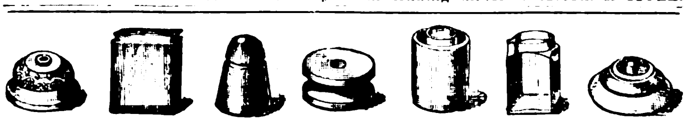

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

We print elsewhere the full text of a Report of the Lighting Committee of the parish of St. James's, Westminster, on the Provisional Order sought to be obtained by the South Metropolitan Electric Lighting Company. It will be seen that the report is moderate and sensible in its tone throughout. We therefore think that the text will be of interest and advantage to those of our readers who may be engaged on schemes for central-station lighting in assisting to form an opinion as to the view which might fairly be taken by the local authority. Most of the objections raised upon points of detail are such as we should ourselves either be inclined to agree with, or else to suggest a *via media*, probably acceptable to both parties. The principal point upon which the Vestry would, we think, be wrong to insist is that wherein they propose the omission of the clause restricting the compulsory supply to premises within twenty-five yards from any main already laid. The Vestry has the wisdom to recognise in its preamble that "any undue restriction would probably interfere with the working of the Order on commercial principles, and therefore indirectly affect prejudicially the interests of the consumers." Now, this clause, which allows the company a choice in the direction of their operations, is absolutely essential to the success of the undertaking during its earlier stages. There is one objection raised, however, upon which we have little doubt that the Order will be quashed—unless serious alterations are made. The Vestry rightly observes that a capital of £250,000 is utterly inadequate to a scheme of the magnitude proposed.

The speech of the Hon. H. R. Brand, who presided at the Submarine Telegraph Company's meeting on Tuesday, has removed all doubt as to the steps which have been taken by the British Government to get possession of the company's cables. The French Government had virtually promised a renewal of the concession, when the English Foreign Office intervened and succeeded in preventing that renewal. We are still left in doubt as to the terms which the company is offered in compensation for this summary extinction of its rights—rights which are recognised at all events on the French side of the Channel, and which were as fully admitted by the English Government itself only ten years ago. But whatever the terms may be we are convinced that they will bear but a remote resemblance to those foreshadowed in the inspired paragraphs which went the round of the press a few months ago. The Central News announcement on the subject yesterday, which we print elsewhere, is probably nearer the truth, although for the most part based on mere conjecture.

It is worth while to remember at this moment that the exceptionally high dividends which this, the oldest, cable company has been able to pay until now have not been extorted by excessive rates. As a matter of fact, the tariff over all the cables owned by the Submarine Telegraph Company has for many years been fixed by the Governments represented at the International Telegraph Conference, not by the company, although with its concurrence.

The paper read last week before the Society of Telegraph-Engineers and Electricians by Mr. Kenneth D. Mackenzie on the Distribution of Electricity by means of Transformers contained some useful information, but it must be allowed that a good deal of the science is, to say the least, calculated to upset one's preconceived ideas, and will probably meet with some severe criticism. Mr. Mackenzie is a loyal adherent of the Gaulard-Gibbs theory of inductional phenomena, and he therefore accepts views which differ widely from those of such men as Mr. Kapp, Mr. Ferranti, Dr. Fleming, Dr. J. Hopkinson, *et hoc genus omne.* Mr. Mackenzie was himself careful to point this out. "It was only," he tells us, "when M. Gaulard came to the conclusion that induction apparatus constructed upon the theory founded by Faraday and exemplified by Ruhmkorff was unsuited for the purpose, that a step was made in the right direction." We learn this fact with considerable regret and even with some apprehension, because the authors whom we have named above have hitherto been content to follow up "the theory founded by Faraday," and it seems unfortunate that men whom we have been led to regard as amongst the leading exponents of the progress of the science should have been so miserably misled. We could wish that M. Gaulard had put this matter right before we had ourselves learnt from them so much that we shall now, it appears, have to unlearn. It is, nevertheless, some consolation to reflect that the blame must primarily rest with Faraday and Clerk-Maxwell, with whom it is perhaps excusable to err.

Accepting the Mackenzie-Gaulard dicta, we find that many curious consequences ensue. As these points of divergence from the theory hitherto recognised will doubtless

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have received discussion at the meeting of the Society on Thursday evening (which at the time of writing has not yet taken place), we shall be content for the time to refer briefly to the four points "which are now known" (by the MACKENZIE-GAULARD school) "as essential features of transformer construction," and which "may, undoubtedly, be ascribed to M. GAULARD" (a claim, by-the-bye, which we think no one will be inclined to dispute). These points are as follows:—1. The reduction to a minimum resistance of the primary and secondary circuits. 2. The obtaining of a maximum coefficient of induction in the two circuits with a minimum in the dimensions and weight of the apparatus. 3. The placing of the primary and secondary circuits in identical positions in respect to the core or magnetic field. 4. The proportioning of the two circuits, primary and secondary, so that their metallic mass should be equal.

THREE at least of these conditions serve very well to accentuate the difference between the ideas expounded by Mr. GISBERT KAPP and Mr. KENNETH D. MACKENZIE. Mr. KAPP attaches primary importance to questions relating to the magnetic cycle of the iron core; Mr. MACKENZIE, ignoring the core, fixes his attention upon the coils, and attaches the highest import to a point which Mr. KAPP in his turn ignores—namely, the direct mutual induction of the two circuits independently of the iron. If we thought it safe to take sides wholly and unreservedly with Mr. KAPP we should remark, on the four "essential conditions" of M. GAULARD, that the first is not true for a transformer working in parallel; that M. GAULARD has not succeeded in the second; and that the third and fourth are conditions which in themselves neither add anything to nor detract from the efficiency of the apparatus. We will only remark further at present that since Mr. MACKENZIE'S method of treatment involves the consideration of *current* generated in the secondary, rather than E.M.F., it is on that account peculiarly difficult to grapple with, especially for those accustomed to the more usual methods. Perhaps this explains the singular fact that in Mr. MACKENZIE'S hands the secondary current varies as the *square* of the primary current.

IT is pleasant to turn from these abstruse considerations, where even doctors differ—or at least Mr. MACKENZIE differs from the Doctors—and to recognise the great value of the information conveyed by the author on several points of practice, especially those connected with the running of circuits for alternating currents; and also the lucid and interesting manner in which the paper as a whole is written. The description of the Kingdon dynamo is peculiarly interesting, and we venture to think that this machine has a future before it..

WE were favoured some months ago with a private view of the "appliances" of the Armstrong Electric Light and Power Company; but as our inspection, like the company, was strictly limited, we took no notice of it in these pages. How very wise the company was in restricting its exhibits to a carefully-locked cabinet containing "the batteries," and the outsides of seven sealed packets, the contents of which, marked with the days of the week consecutively, had to be administered to the said batteries, is proved by what has since happened. The Armstrong Company has issued its prospectus, and its demand for the modest sum of £20,000 by way of capital has actually met with some response. One of the subscribers now writes to a contemporary under grave suspicions that he has lost all he subscribed; and certainly, if the description in the *Financial News* of the manufacturing premises occupied by the company is at all accurate, it certainly does seem probable that the subscribers will gain nothing but a little valuable experience. Our own experience cost us only a short walk; and we strongly advise capitalists to always invest in that cheap and healthful exercise before risking their money on inventions which are shrouded in mystery, and about which technical journals are not allowed to form an opinion.

THE discussion at the Physical Society on Saturday last on the use of the term "magnetic resistance" to indicate the ratio between magneto-motive-force and magnetic flux (or in still more familiar terms, between ampere-turns and lines of force per unit area), may be taken to stamp with authority the employment of the term in question. We regard this result as satisfactory, because, while we have not, for our own part, been able to see any valid objections to its use, yet so long as Dr. HOPKINSON and Mr. OLIVER HEAVISIDE'S objections remained unanswered, we have naturally felt a little uncomfortable when applying it. If these gentlemen still hold to their repudiation of the term, perhaps they will now suggest an equivalent.

WE are glad to see that the first annual meeting of the Taunton Electric Light Company has passed off so satisfactorily. Some of the shareholders of the local gas company have of late busied themselves in spreading rumours disadvantageous to the financial position of the company. The payment of a 5 per cent. dividend, carrying forward a substantial balance satisfactorily disposes of these rumours. The practical working of the installation evidently meets with the full approval of the major portion of the inhabitants, who are quite prepared to continue paying the extra cost entailed by the use of electricity.

THE opening of the New Electric Club House in New York seems to have been quite a brilliant affair, and promises well for the future of the electrical profession. The building is described as spacious and handsome, and so arranged as to meet the requirements of a Scientific Society while fulfilling all the purposes of a professional club. About 400 members engaged in electrical business or research have been already enrolled; and it is probable that similar clubs will be started in other large towns of the United States. We know of no institution in this country exactly corresponding with the New York Electric Club House; nor perhaps is there any need for it, the habit of Englishmen being emphatically to drop their business when they go to their club. England, however, possesses an abundance of separate institutions representing all branches of science and industry; and it is mainly to make up for its

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deficiency in this respect that in New York the functions of club and institute are sometimes combined.

PROF. ROWLAND dwelt on this point in the course of his interesting address at the opening of the Electric Club, remarking upon the advantages which FARADAY enjoyed in being so closely associated with the science of Europe, encouraged by the Royal Society at which to announce his discoveries, and by the Royal Institution in which to make them—advantages which no man, however naturally endowed, could have obtained in America either then or now. Prof. ROWLAND'S address, brilliant and sympathetic as a scientific memoir of FARADAY, was still more valuable as an appeal to American public spirit to emulate the example of the old country, which has always been in the forefront of scientific progress.

OUR New York correspondent calls attention to the utilisation of wind-power for electric lighting. This idea is, of course, a very old one—we believe it was first propounded by Sir WILLIAM THOMSON in his address to Section A of the British Association in 1881, though Sir WILLIAM was careful to point out that the successful application of this force would necessarily be confined to a small scale of working. But, as our correspondent rightly says, it is only since storage batteries have obtained their recent development that the scheme has come within the range of practice. We have reason to believe, however, that a plant of this description will be on view at the forthcoming Glasgow Exhibition, and we hope shortly to be able to give some further account of the arrangements adopted. Meanwhile we may refer those of our readers who are interested in the subject, to an article in our issue of August 27th, 1886, in which some numerical data will be found.

St. Pancras Station.—We understand that the Midland Railway Company are about to light the St. Pancras Station with the Thomson-Houston system.

Cheltenham.—At the meeting of the Cheltenham Town Council on Monday last a resolution was unanimously adopted directing the Streets and Highways Committee to report upon a scheme for the introduction of electric light, and giving power to obtain the advice of an expert.

Private House Lighting.—The electric light is being introduced into the country residence of Baron Schroeder at Egham. The plant will consist of two gas engines and two of Elwell-Parker's latest inverted B type dynamos. The work is in the hands of Messrs. Drake and Gorham.

Lighting of the Royalty Theatre, Glasgow.—This theatre has recently been supplied with an electric lighting plant by Mr. Geipel, of Edinburgh. The installation was brought into use for the first time on Monday evening last. We shall shortly give a further detailed description of the plant.

Paris.—A circular issued by MM. Ch. Mildé, Sons and Co., of Paris, informs their clients that, owing to the exigencies of the regulations made by the Municipal Council affecting electric lighting, they have been compelled to abandon the idea of establishing a central lighting station in the quarters of Monceau, Malesherbes, Ternes, and Champs Elysées.

The American Bell Telephone Company in Mexico.—The First District Court of Mexico has pronounced a decision confirming the validity of the Bell Telephone patents in that country. The action had been brought in order to test the right of importing telephones of German manufacture. There will, however, be an appeal to the Supreme Court.

Edmondson's Calculating Machine.—We are informed that Mr. Edison has recently ordered one of these remarkably ingenious machines for his new laboratory at Orange, New Jersey. This apparatus is capable of performing addition, subtraction, multiplication and division, there being no limit to the number of figures with which it is capable of dealing.

Spanish Tender for Telephone Service.—The *Madrid Gazette* of Monday last (February 13th), contains a Royal Order authorising an invitation for tenders for the establishment and working of a telephone service in Cordoba, subject to the conditions published in the official journal of 15th June, 1886. Tenders are to be adjudicated upon on March 16th next.

The Electric Light in Railway Carriages.—At the meeting on Wednesday of the Great Northern Railway Company the Chairman (Lord Colville of Culross, K.T.) stated that they had been engaged on experiments connected with the use of the electric light in their carriages, for which purpose the proprietors' sanction was required for an expenditure of £552. They had at present three trains running lighted by electricity.

A Large Galvanometer.—A large galvanometer has just been completed by Mr. Forée Bain for the United States Government. It is a combined tangent, sine, cosecant, and differential galvanometer. It will measure currents up to 1,000 amperes, E.M.F.'s up to 3,000 volts, and resistance up to 10,000,000 ohms. This instrument has been on exhibition at Giles Bros. and Co.'s, New York, where it has attracted much attention.

Telegraphing Bismarck's Speech.—On the day of Prince Bismarck's recent speech in the German Reichstag, which contained 10,997 words, no fewer than 1,218 press telegrams, comprising 194,296 words, were sent from Berlin to 326 different places in Germany and abroad. The forwarding of these telegrams was effected by 235 officials on 222 instruments, sixty of these being Hughes, 155 Morse, and 7 Etienne. The longest telegram sent to any non-German journal was that addressed to *The Times*.

New Zealand.—According to advices from Auckland an experimental installation of arc lights to illuminate Queen-street was in preparation for Christmas, the undertaker being Mr. Firth, who has offered the use of the lights gratuitously for a fortnight, previous to entering into an engagement with the Corporation. Messrs. Ashcroft, who had previously contracted to supply the light but failed in some of the conditions, owing, as is alleged, to the interference of the telegraph department, are claiming damages from the Corporation.

Railway Tunnel Lighting in Russia.—According to the *Engineer*, upon the line between Kieff and Odessa some of the railway tunnels are provided with a plant for lighting the trains which traverse them by a method similar to that carried out upon the underground railway in Glasgow. There are three circuits—in different tunnels—of 2,000ft., 1,460ft., and 6,540ft. respectively. The rails are used for the return conductor, and the main cables are laid in a central channel between the tracks. Contact is made in each tunnel with the wire for that circuit by trailing pulleys on the car axles. Each car has its own contact with the wire, so that all complicated connections of coupling a train are avoided. The company has applied the system to seventy-four cars, and they report that the expense of the system is less than one-third the cost of gas.

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A Syndicate of Electricians in Belgium.—According to the Brussels correspondent of *Industries*, it is proposed to establish an electrical syndicate; but there will be some difficulty in arriving at a proper understanding as to the share each firm is to have of the business that comes in. One of the main subjects for which the syndicate is being formed is to light the town by electricity, and in order to do this it is proposed to buy up the gasworks. Failing this, which would cost some millions of francs, a central station would be established to supply the electric part of the town. The syndicate also intends to acquire the most important electrical patents, so as to put down outside competition. The project is very good on paper; but whether it can be realised, says our contemporary, is another matter.

The Thomson-Houston System in the West of England.—The *Somerset County Gazette* says:—Owing to the damaging statements made by Alderman Bruford and other shareholders in the Taunton Gas Company respecting the reliability of the electric light in that town, members of the Local Board and other gentlemen who are desirous of seeing the electric light introduced into Weston have privately visited Taunton upon several occasions during the past few weeks, to test the accuracy of Mr. Bruford's statements, with the result that they are unanimously of opinion that there is no justification for such statements, the light upon each occasion being in every respect equal to what it was when the deputation visited Taunton on November 18th, 1887. It has now been definitely decided to use only the system adopted in Taunton (the Thomson-Houston) in the event of the electric light being introduced into Weston-super-Mare

The Paris Exhibition, 1889.—As announced in our last issue, a preliminary meeting of intending exhibitors at the Paris Universal Exhibition, 1889, was held on Monday last at the offices of the Society of Telegraph-Engineers and Electricians, which was attended by several of the leading London electrical firms, and it was "Resolved that in the opinion of this meeting it is desirable that the Society of Telegraph-Engineers and Electricians should accede to the request of the Director-General of the Exhibition that they should undertake the organisation and general representation of the British electrical section." We understand that a circular will probably be shortly issued calling a more extended meeting, with the view of ascertaining the full extent to which British electrical industry will be represented at the Exhibition. Already many important firms besides those represented at the meeting on Monday have signified to the society their intention of exhibiting.

Weston-super-Mare.—A correspondent writes:—"At a meeting of the Town Commissioners held on Wednesday, the 8th inst., an amendment to the minutes of the Lighting Committee, which recommended the adoption of twenty arc lamps on the sea front, was carried after a lengthy discussion, the amendment being to the effect that the minutes of the Lighting Committee be not accepted. At the same meeting of the Board a proposal, which was carried unanimously, was made that a committee of the whole Board should reconsider the subject, with a view to the town undertaking the lighting and providing its own appliances therefor. This is as it should be, for the electric light is regarded with considerable favour in the town, which has been shown by the several deputations which have waited upon the Board, and also by the large number of letters on the subject in the local papers. It is a great pity that it will not be ready for the ensuing season, when the Somerset County Agricultural Show will be held here."

Underground Wires at Brooklyn.—The Brooklyn Electrical Subways Board of Commissioners do not seem to have prospered in their further endeavours during the past year to get the aerial wires of that city put underground. According to their fourth annual report, just issued, the operations of the Board have been virtually stopped by another Brooklyn Board, the Board of Aldermen, who refused to let the streets be opened for the construction of the subways until compelled to do so by the Courts. Matters are going more smoothly now, and there is a growing desire on the part of the several electrical companies to comply with the law. Most of the wires have been removed from the poles; but unfortunately the poles still remain standing, with a few wires hanging on to them belonging to the police department, who profess their inability to remove them. This want of co-operation between the several city authorities or Boards has led to the suggestion that the elevated railroad system should be utilised for all kinds of wires, thus dispensing with the conduit system as well as with poles.

The Exhibition of Apparatus Connected with Atmospheric Electricity.—The Royal Meteorological Society has issued the following circular:—"The Council of the Royal Meteorological Society have arranged to hold at 25, Great George-street, Westminster (by permission of the Council of the Institution of Civil Engineers), on March 20th to 23rd next, an Exhibition of Apparatus connected with Atmospheric Electricity, including Lightning Conductors, Photographs of Lightning, and damaged objects. I am therefore instructed by the Exhibition Committee to invite your co-operation, as they are anxious to obtain as large a collection as possible of such apparatus, &c. The committee will also be glad to show any new meteorological instruments or apparatus invented or first constructed since last March, as well as photographs and drawings possessing metereological interest. Should you be willing to co-operate in the proposed exhibition, I should be obliged by your furnishing me (not later than March 1st) with a list of the articles you will be able to contribute, and an estimate of the space they will require.—I am, sir, your obedient servant, William Marriott, assistant secretary."

The Lighting of Victoria Station.—The Victoria Station of the London, Brighton, and South Coast Railway Company has at length been supplied with electric lighting plant. There are thirty-five arc lamps of 2,000 nominal candle-power, supplied by current from a single dynamo of the Woods type. The lamps are arranged in series, all on one circuit, but this circuit is divided into four sections, the ends of which are led to a switch-board in the dynamo room. The dynamo automatically adjusts the position of its brushes in accordance with the number of lamps burning. To this end the spindle bears at its termination a small frictional wheel which can be put in gear with either of two other frictional wheels on a swing frame. This frame is connected to the cores of a pair of solenoids traversed by the current, and if the current becomes greater or less than the normal, the cores move the swing frame to bring the frictional wheels into gear, and through their agency and that of a train of toothed wheels, to move to brushes round the commutator. The power is derived from a 16 horse-power (nominal) Crossley gas engine. The installation has been carried out by Messrs. Verity and Sons, of King-street, Covent Garden.

The Institute of Medical Electricity.—We have received a copy of the prospectus of the Institute of Medical Electricity (Limited), which is advertised in our columns this week, and note that the company seems thoroughly genuine and *bonâ*

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fide. A very encouraging feature is that several of the best medical and electrical men have combined to support the institute. Accompanying the prospectus there is a memorandum of recommendation, signed by eight doctors of eminence, including a past president of the Royal of Surgeons and a vice-president of the Royal College of Physicians. There is also a list of "visitors," containing the names of an equal number of medical and electrical men of the highest reputation and position, among the latter being several past and present officers of the Society of Telegraph-Engineers. The fact that Mr. W. Lant Carpenter, B.A.,B.Sc., M.S.T.E., is one of the directors, and that two others, including the manager, are associate members S.T.E., will be a guarantee that the much abused subject of medical electricity will be dealt with in a proper manner, and that the high standard they have adopted for the institute will be maintained. The directors do well to offer the shares to medical and electrical men in the first instance, for we cannot doubt that for so excellent an undertaking the small capital asked for will be readily subscribed by them, and it is only right that the control should be in the united hands of those professions. Those of our readers who require fuller information cannot do better than write to Mr. H. Newman Lawrence, the manging director, at the temporary office of the company, 16, Clifford's-inn, E.C.

Electric Lighting of the City.—The Streets Committee of the City Commission of Sewers, to whom it was recently referred to further consider the proposed arrangement with the Anglo-American Brush Electric Light Corporation for lighting a district of the City by means of electricity, have submitted their report to the Commission. The company have agreed to deposit £1,000, to be forfeited in the event of their not commencing their work within six months from the signing of the contract or not completing the installation by October, 1889, and also to the insertion of a clause that in the event of the Commission seeing reason to terminate the contract for public lighting within the seven years the company's exclusive right of way for private lighting shall then cease. The district proposed to be lighted commences from the front of the Royal Exchange, and comprises as much of the City as lies between the Poultry, Cheapside, St. Paul's, Ludgate-hill, and Fleet-street on the north, and Queen Victoria-street and the Embankment on the south. The contract for public lighting is to be for seven years, from the 31st of October, 1889. The price for each arc lamp of 2,000-candle power is to be £26 per annum. The Commission propose to grant to the company, so far as they are able and conditionally on the company commencing and completing the public lighting, the exclusive right of supplying private lighting during the same period. The license given for private lighting is to be subject to immediate termination if it is decided by any court of law that the Commission cannot legally grant such powers, and in that event the company are to be at liberty to determine the contract as to public lighting by giving a month's notice. The report will come before the Commission for discussion on Tuesday next.

Incandescent Lamps in Mines.—A writer in the *South Wales Daily News* says:—"It seems to be now pretty well understood that the universal adoption of the electric light system in our collieries is only a question of time. Several mining districts, Treharris, Cwmpennar, and Maerdy, for instance, the coruscations of whose beacon-like electric luminaries are to be seen at a distance in the night, have enjoyed for some time past the advantages afforded by the new light on the surface. The only difficulty and misgiving I hear of that are likely to militate against the idea of flooding the inner regions of our collieries with electric light are the high price of the electric lamp, and a fear prevailing among colliers that the general utilisation of it may lead to a dangerous neglect of duty in the ventilation of the works. The slow poisoning process of the inhalation of air impregnated with gases would evidently do more havoc with the lives of underground workmen than an occasional explosion. But a revival of trade would soon enable all to surmount the monetary difficulty, and the power to inspect mines with which the miners themselves are now invested would, one should think, be a sufficient safeguard to prevent the neglect apprehended. Advantage was taken of this provision of the new Act last week, at Mountain Ash, where, without giving any previous information to either the management or the workmen, six experienced colliers, summoned by the checkweigher for the purpose, explored the colliery in which they were employed, and afterwards presented a satisfactory report. I expect that presently the underground population of our colliery districts will hail with great delight the dawning of the new era of the electric light turning their night into day."

Lighting of North Shields Markets.—The electric lighting of the North Shields markets, which has been carried out by the Gülcher Electric Light and Power Company, has now been in working order for over a month. The installation has been carried out in a very complete manner, and we understand that it is giving entire satisfaction to the Corporation. The plant consists of a 20 horse-power nominal Marshall's compound undertype engine, fitted with a long crank-shaft extended on one side of the engine, and supported by a third bearing; the extended length of shaft provides sufficient room for the addition of one or two extra pulleys or fly-wheels, an extension of the installation being contemplated. By this method extra dynamos may be driven without counter-shafting. The engine is very complete in every respect, being fitted with a Worthington pump for feeding the boiler, steam trap for draining the jackets, and relief valve to the low-pressure cylinder. The engine drives by an endless band on to a 12-unit Gülcher compound-wound dynamo, giving a current of 185 amperes at 65 volts, at a speed of 1,000 revolutions per minute. The machine is mounted on a cast-iron sliding bed plate, with tightening screws, and works without any sign of sparking. The current from the dynamo is taken to a handsome main switch and cut-out board, mounted on a slate slab, carrying 14 sub-circuit switches, with cut-out to each. Above the switch-board a rheostat frame is placed, carrying 16 resistance coils, with adjustable sliding contacts. By this arrangement all resistance coils are kept in the engine room, and under the eye of the driver. A voltmeter and ammeter are provided for measuring the current and E.M.F. After the current leaves the switch-board it passes by single circuits of $\frac{7}{18}$ cable to the 15 2,000 candle-power arc lamps arranged in two lines along the markets, and is carried back by the main negative lead to the switch-board. All the cables are run in continuous casing, grooved out to carry the arc light circuits, and also an incandescent circuit for lamps on each side of the market. The arc lamps are of the usual Gülcher globe type, with telescopes for lowering the globes for recarboning, each lamp being fitted with a raising and lowering gear. The stalls in the markets are lighted by incandescent lamps, suspended by flexible pendants from the ceiling; the engine room and other offices are also lighted by the same means. This installation affords an example of the convenience of the parallel system of arc lighting for places where the lamps are placed within a reasonable distance of the dynamo, and a combination of arc and incandescent lamps is required.

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A PROPOSED NEW PUBLIC TELEPHONE SYSTEM FOR CITIES AND LARGE TOWNS.

BY WALKER MOSELEY.

(Continued from page 314.)

In returning to the consideration of the first great difficulty in the way of a distributive telephonic system, viz., to secure insulation, I know it is important to clear away many conflicting opinions and doubts which beset telephonic experts, as such. Any attempt to be at the same time concise and precise in carrying that out would delay the realisation of a general unanimity amongst that elect class of telephonic technical experts which in any sense guides telephonic financial experts. I trust, therefore, the following remarks will be carefully weighed, for at the present time it begins to be seen that if confusion of ideas should exist much longer concerning the most troublesome facts in practical telephony, inferences will be drawn that may seriously shake public confidence in public telephony. The confusion I am more especially referring to is that which may be characterised as a half public confession that, however perfectly the system may be insulated, there will remain a liability (to use an Americanism) to "cross talk," or I would rather say *stray talk.* Now, this is true only on the supposition that an "earth" return must be always used. So long as that is in vogue the following must ensue as a rather common coincidence, viz., that when speaking through a line whose route outspans a shorter line—no matter how perfectly both lines may be insulated—the speech through the long line could be heard by listening at the telephone at either end of the short line. All that can be said to minimise this fault is that the speech on the short line will be "faint." But "faintness" is comparative in more senses than one. In some cases of faintness there is plenty of volume if the articulation were good. In other cases the articulation is so good that although only one-hundredth part of the volume of the speech—to one used to the telephone—is perfectly intelligible without effort on the part of the listener. Indeed, I have frequently heard a score voices at once, several of which voices were so characteristic that I have followed every word of whichever voice I chose to follow. Whereas, if the voices were listened to in their ordinary volume in a room, the combined volume of sound would prevent any voice being intelligible. An agreement as to these facts would cause great hesitation in resorting to any great outlay with the object of securing perfect insulation. But if a complete metallic circuit, or, in common phraseology, if a well insulated wire be used for the whole distance there and back, it is impossible for such effects to occur, and it at once becomes worth while to calculate whether it would not be worth while to incur even a greater outlay than ever dreamt of hitherto. Further consideration will also show that the very thing that is necessary to shut out *stray talk* is the only means that enables us to overcome our second great difficulty, viz.:—

2.—To Kill Induction.

Common conversation amongst telephone experts brings out more or less distinct but unanimous deprecation of the idea that a complete metallic circuit always kills induction. Mixed up with this flattering unction is a slight recollection of this elementary fact—viz., that the effects of induction are, in the absence of leakage, greater in proportion as the wires are better insulated. As a lecture table experiment a very simple demonstration is enough to reason from in the present instance. For example, take a coil of three wires, say a mile in length, wound simultaneously side by side. Connect up two of these wires as one telephone circuit, and the third wire as another. Speak on the double-wire circuit and listen on the other, when no sound will be heard; whereas, if two of the same wires are used as two separate circuits, then induction effects will be observed.

I am prepared to contend that there is no practical difficulty in securing similar results in general use without resort to more expensive means than present subscriptions will cover.

The system of distribution by which I propose to secure the above objects will be better understood after a careful examination of the illustrations and some further explanations in a later issue of this journal.

D and E (Fig. 2) represent two iron conduits shown in section in Fig. 3, K K'. I propose that a large proportion of the conduits shall be in section 2in. by 2½in., and the wires contained in metal tubes—to be explained more fully later on—to be of such a section that 100 will, with the addition

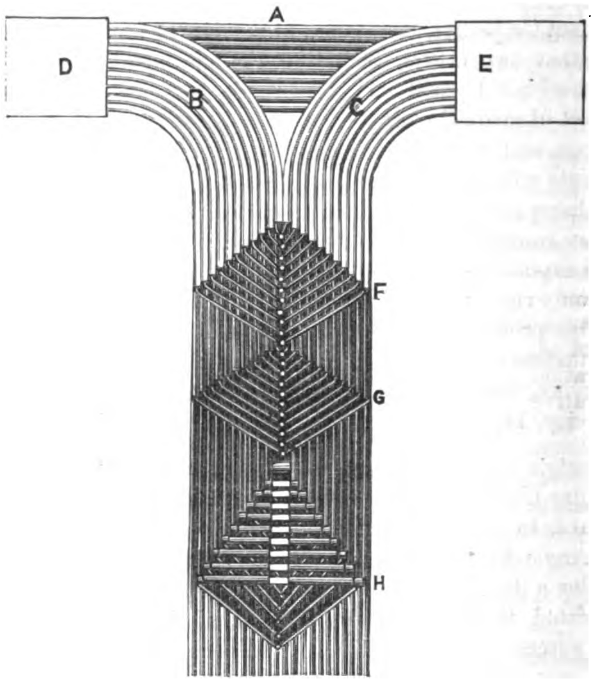
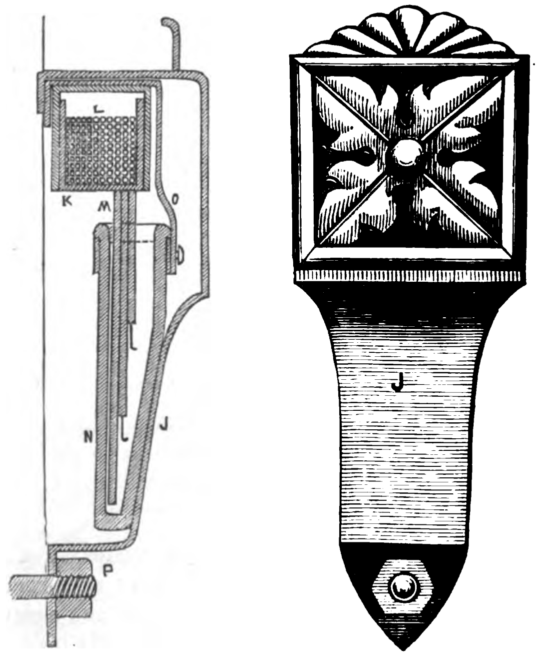


Fig. 2.

of a hemp serving on each tube, nearly fill the conduit K. A represents a series of these tubes running past a junction in the conduits, and B C turned down for jointing. But it must



Figs. 3 and 4.

be observed that where some are turned down for jointing, whilst others run straight on, they will usually be treated in a different order from that shown in the drawing, the object of the illustration being to show the method in its simplest form. F G and H (Fig. 2) are three series of ten-jointed, the lower

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series showing the tubes bridged across with soldered joints. L (Fig. 3) represents 70 tubes in section, and M 30 tubes turned down, or, in other words, A, B, C, F, G, H (Fig. 2), shown in section and side view respectively. N is an earthenware well to be filled with oil, supported by the metal strap O. The letters J, J (Figs. 2 and 3), represent a metal cover to imitate an architectural truss, shown in front view in Fig. 4. The bolt and nut P secure the cover against the wall. Perhaps the most obvious of the advantages of this method of jointing the wires and insulating the bare joints is that every wire may be known by its relative position in the perpendicular series of joints, so that every conduit being numbered and every series of joints being numbered, the position of the wire will be given by a third number, thus $\begin{matrix}25\\13\\10\end{matrix}$, or 25—13—10, will mean conduit 25, junction 13, wire 10, so that not a moment will be lost in getting at any wire for testing or alteration, and in going over the process of laying the tubed wires in the conduits, waterproofing the same and making the soldered joints, it will be found that the time occupied will be less than the ordinary way of doing the same quantity of work. But, of course, to obtain this result, at the outset there is not only a set of mechanical contrivances for effecting each operation but for the jointing processes in new plant a set of operatives who have had years of training in similar work will be employed. The process devised for unsoldering any joint for testing or alteration is so manageable and expeditious that a joint can be undone and joined up again in half a minute, and no matter how many tests be made at any of the junctions, it will be seen that the whole series may be insulated in a moment by lifting up the oil-well for their immersion. The expedition attainable by this system for testing operations will enable one man to trace out a fault in a two-mile line in 36 longitudinal sections up to the particular section containing the fault within three hours. The number of operations involved, and the length of time necessarily occupied, will on this system be almost uniform for a line running through any given number of junctions. The supposition—based on precedents improved upon—is that faulty insulation in any longitudinal section of tubed wires will be exceedingly rare; but wherever it may occur a spare wire will be immediately joined up to bridge over the faulty length, and before all spare wires are used up additional wires will be laid alongside in a new conduit. It may appear strange to speak of a two-mile line being divided into thirty-six lengths, and it may be supposed that some practical difficulty necessitates laying up the wires in such comparatively short lengths. But that is far from being the case. One of the reasons for the adoption of short lengths is that as there will be no loss at the junction, neither of insulation nor conductivity, it would be bad policy to neglect any opportunity for providing for future contingencies of any kind so long as present efficiency is secured. Amongst other contingencies there is the uncertain proportion that will exist between long lines and short ones, as well as private wires. The latter having been up to the present a practically boycotted branch of telephony, calculations in detail under these heads will show that numerous junctions will tend to economy. But the greatest advantage will be that any imperfection in the form of either leakage or rupture can be immediately remedied, and every line can be kept practically in a uniform state of perfect insulation and conductivity.

In stating this I am not losing sight of the palpable disproportion between the amount of insulation obtainable between the wires and the tube, as compared with that between the tubes, and since the illustrations will show that each tube is intended to form the "return" for its own wire, it will appear that very little space is allowed for the insulation between the tubes. But I shall show later on how any failing of insulation between the tubes will be remediable without disturbing them in their respective conduits, whereas the wires can have a sufficient margin to protect them against all contingencies, with only a quarter of the material that the tubes would require. I shall presently proceed to describe the method of insulating tubing and laying up the wires, which, although well-known principles are introduced, will be found to fulfil several practical requirements by a new combination of parts and processes.

It will then be possible to form a fair estimate of the total cost of the scheme on the proposed scale. After submitting such an estimate, I will then describe where improvements may be made in all the instruments at present in use, with special references to long-distance telephony.

(To be continued.)

EXPERIMENTS ON THE CONDITIONS WHICH DETERMINE THE STABILITY OF A TELEGRAPH WIRE.

BY FRANK CAWS.

PART I.

It has heretofore been usually assumed amongst telegraph-engineers that the dip and stresses of telegraph wires may be calculated with sufficient accuracy for practical purposes by neglecting altogether the existence of a modulus of elasticity, and proceeding as if the wire were absolutely inelastic.

It is upon this assumption, for instance, that the table contained in Mr. Preece's paper "On Copper Wires" (read before the British Association, Manchester, 4th September, 1887) has been calculated.

It is the object of the following paper to show that we cannot afford to neglect the elasticity of the wire.

I stated, in a letter to *The Electrician*, 21st Oct., 1887 (without making special reference to the table issued by Mr. Preece, and as a general principle), that calculations of dip and stress due to various temperatures, if allowing only for expansion and neglecting elasticity, would give an incorrect result, greatly exaggerating the differences of stress and dip in winter and summer. I made this statement incidentally, in dealing with the question of springs on telegraph wires. Mr. Preece, in *The Electrician*, 28th Oct., 1887, wrote that I had "failed to realise the conditions which determine the stability of a telegraph wire." This remark compelled me to prepare a table of dips and stresses at various temperatures, which I published in *The Electrician*, 4th Nov., 1887. This table showed that when the expansion only was allowed for and the elasticity of the wire neglected, the results closely corresponded with Mr. Preece's table; but that when the elasticity was allowed for the differences from Mr. Preece's figures were considerable. My table of 4th Nov. was, as therein stated, founded upon a modulus of elasticity = 14,500,000lb. per inch of sectional area of copper wire. On the 9th Dec., 1887, I published in *The Electrician* further tables showing the stresses due to snow on the wires, and the capacity of springs to yield relief from such excess stresses. I mentioned that some text-books placed the modulus of elasticity for copper wire as high as 17,000,000lb., and added that, if such were the modulus, its effect would be to render the dips very slightly more, and the stresses very slightly less, than shown by my table of 4th Nov., founded on a lower modulus.

And at the same time I explained that the tables were all calculated as if the catenary were a parabola. On December 8th, 1887, I prepared a table of dips and stresses due to a modulus of 17,000,000lb., still calculative as if the catenary were a parabola. The dotted lines C on the diagrams 2, 3, 4, are given by my table of the 4th November. The firm lines E on the diagrams 2, 3, 4, are given by experiment, as hereinafter described. I cannot show on these diagrams 2, 3, 4 the line due to the 17,000,000lb. modulus, because at diagram 2 it lies between C and E, at diagram 3 it lies practically on E, and at diagram 4 it lies so small a distance below E as could only be shown by thickening the line E a little at its vertex. The lines P in these diagrams are given by Mr. Preece's table; and show almost exactly the effect of expansion on the wires *if* they were absolutely inelastic. The line in diagram 1 is marked C E P because it is the datum at which the tables and experiments are all made to agree in dip. Serious as are the differences between the dips given by Mr. Preece's table

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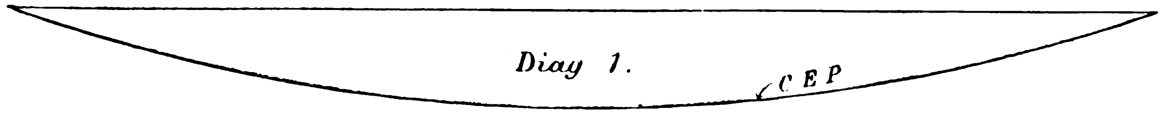
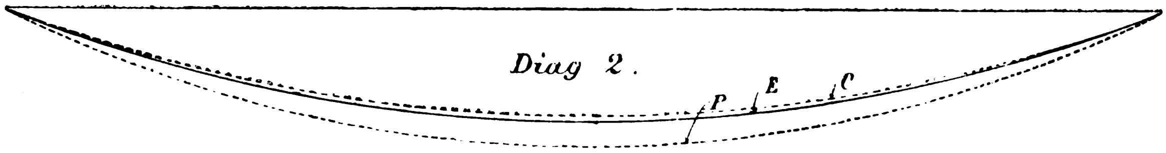
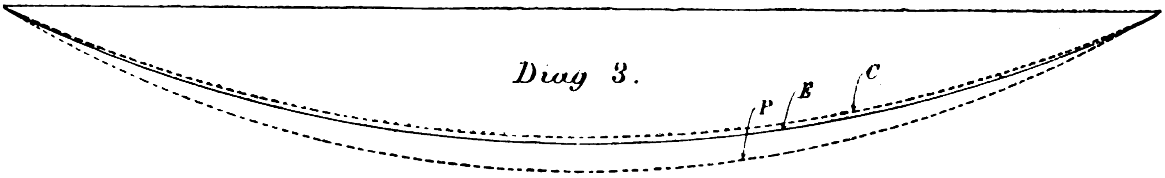
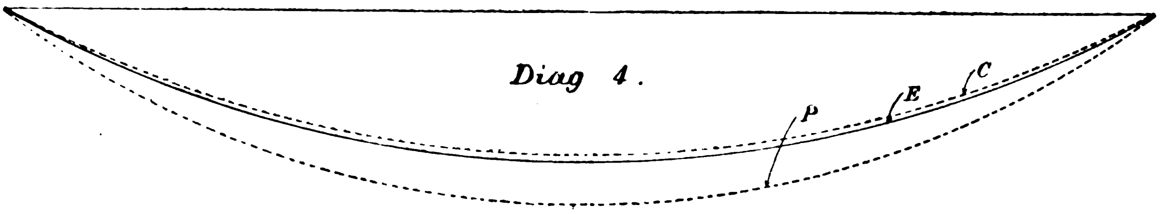
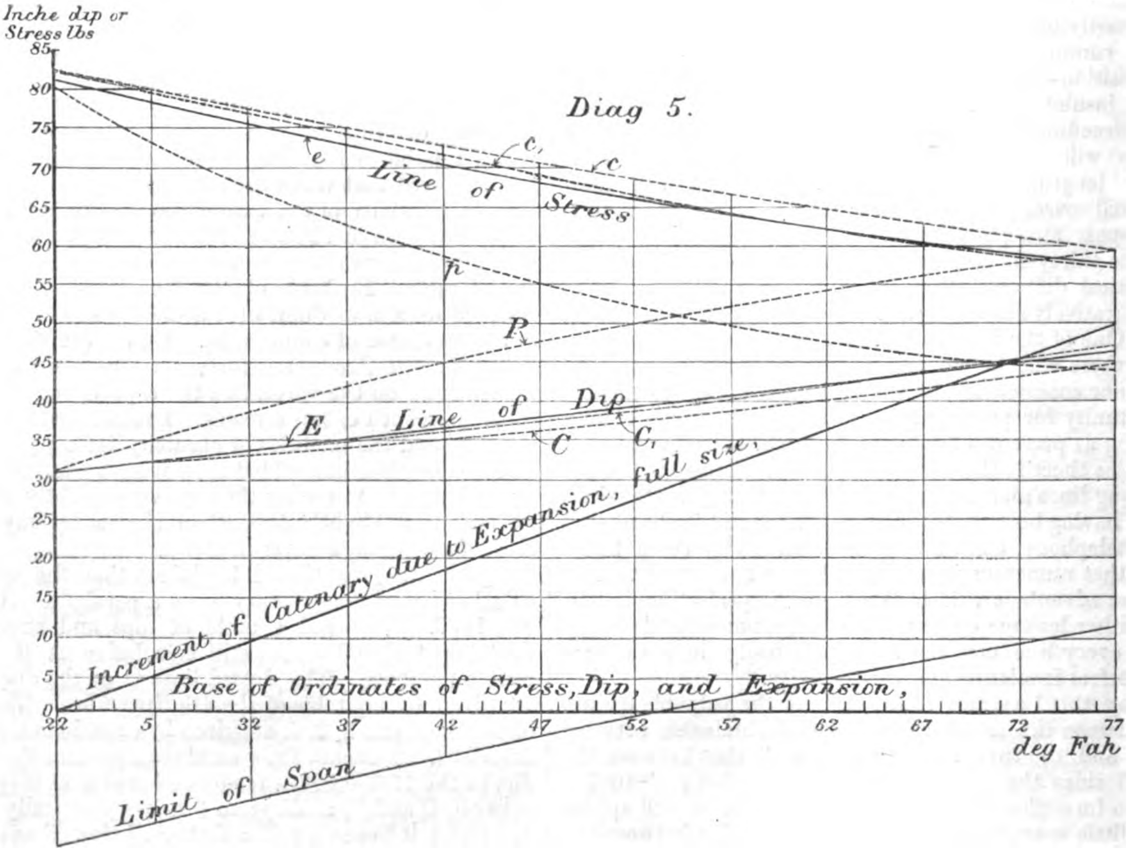
and by experiment, the differences of stress between Mr. Preece's table and experimental results are still more serious. This is shown by diagram 6, whereon the firm line *e* gives the stresses as per experiment, and the dotted line *p* gives the stresses as per Mr. Preece's table, while the dotted line *c* gives $\frac{1}{10}$in. per deg. F. By measuring the line *e* for any intermediate temperatures (between the points which were experimentally taken at 18deg. apart) the telegraph or telephone engineer will obtain the true stresses for such intermediate temperatures, agreeing with a factor of safety = 4 when











the stresses as per my table of 4th November, *i.e.*, for 14,500,000lb. modulus, and dotted line c_1 gives the stresses as per 17,000,000lb. modulus. The vertical ordinates of diagram 6 are to a scale of 25lb. stress per inch, or 25in. dip per inch; and the horizontal co-ordinates are to a scale of the breaking stress of the wire is 330lb. For example, at a temperature of 50deg. F. the stress will be found to measure, by scale on diagram 6, about 67lb., which will be correct. In order that this diagram 6 may be of still more value to telegraph and telephone engineers, I have repre-

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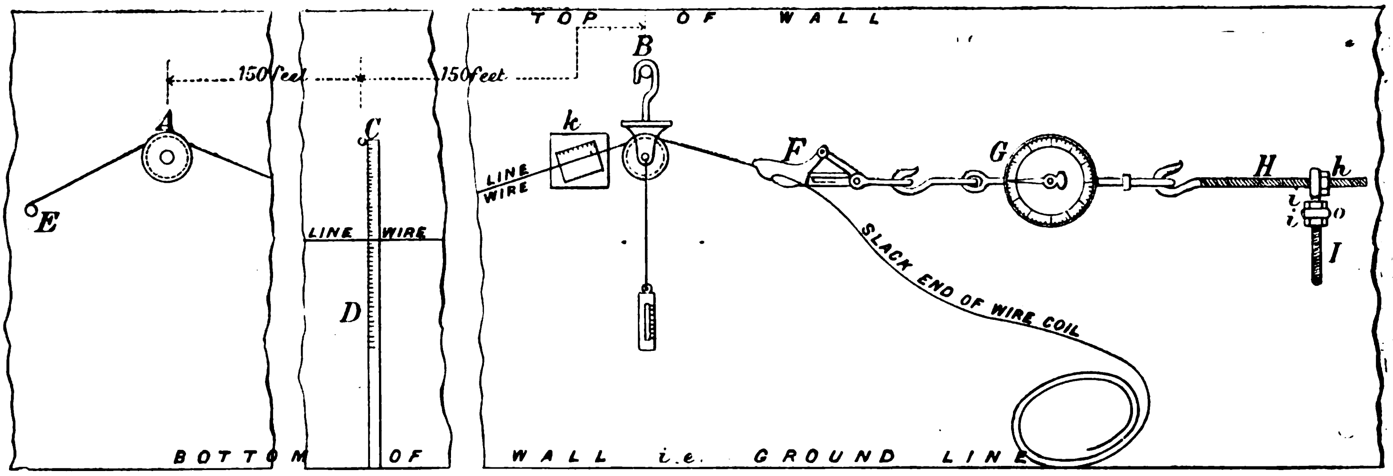
sented thereon the experimental dips for various temperatures by the curve E, by means of which the dips for any intermediate temperatures may be found by scaling the diagram. For example, at 50deg. F., the dip scales 38$\frac{3}{4}$in., which is correct. It will be observed that the curvature of the line E is so slight as to be inappreciable, between 22 and 77degs. F. That is to say, the curvature is too small to show on the scale of the diagram. But the figures of the annexed table of experimental dips show the slight curvature which really exists; and a little reflection will convince the student that were there no curvature in the line E, diagram 6, the dips would become zero at about 123deg. F. below zero, which is absurd, because to have a zero dip we must have an infinite stress. Hence it follows that in diagram 6 the line E is a portion of a curved line, which, if continued, would evermore approach but never reach its base line, which base line is therefore its asymptote. The curve of dips marked P on diagram 6 is according to Mr. Preece's table. This curve bends the wrong way (viz., concave towards its asymptote), besides being, as I showed by diagrams 2, 3, 4, a long way wrong in its ordinates generally. The curve of dips marked C on diagram 6 is according to my 14,500,000lbs. modulus table, and the curved marked C_1 on diagram 6 is according to my 17,000,000lb. modulus table. Both C and C_1 bend the right way (viz., convex towards their asymptote), and while both are nearly the same as the experimental curve E, the line C_1 is so nearly identical with the experimental line E as to leave no room for doubting that 17,000,000lb. is the modulus of elasticity of copper telegraph wire, or is sufficiently near the true modulus for all practical purposes. Thus my immediate object in making these experiments—viz., the ascertaining of the true modulus, and testing my table—has been accomplished.

Diag 6.



With view to make diagram 6 of still more service to telegraph and telephone engineers, I have added a "Line of Catenary Increments." This line gives the full-size measure of increments to catenary arc (dating from 22deg. F.) due to expansion. For example, the expansion of the catenary arc, per 100 yards span, from 22deg. F. to 50deg. F., measures per the 50deg. ordinate on diagram 6, from line of increments down to base of ordinates, exactly 1in., which is correct. It is also useful to engineers to know how much the catenary length exceeds the length of span for any temperature between 22deg. F. and 77deg. F. This can be at once learnt from diagram 6, by measuring from the line of expansion-increments down to the curve marked "Limit of Span." For example, the catenary at 50deg. F. is thus found to measure about 1$\frac{1}{10}$in. longer than 300ft. span, which is correct. Thus the engineer may read at once, off this diagram 6, the stresses, dips, expansions, and catenary lengths, due to any given temperatures, between 22deg. F. and 77deg. F., for a 100lb. copper wire, strained to quarter breaking tension of 330lb. and a span of 100 yards. It would be easy to prepare similar diagrams for any spans and qualities and conditions of wire.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER VII.—*Simple Tests with Indicators (continued).*

(Continued from page 350.)

79. In an insulation test of any line the line wire itself will not be connected to the instrument direct, but generally through a "leading in" wire. As the line is tested through this wire, it is important to see that it is itself well insulated. To do this the end of the leading wire affixed to the line should be disconnected or "freed" for a moment or two while the battery is put on as before and it is observed whether the indicator shows any deflection; if it does, it shows there is a leakage between the leading wire and earth. Since this would falsify the results when the line is tested, allowance must be made for it in the following manner:—Work out the insulation resistance between the leading wire and earth exactly in the manner described for a line. Now, on connecting up the line and measuring its insulation it is evident that instead of obtaining the true insulation of the line we measure the *joint* resistance of the insulation of line and leading wire because these two resistances are connected together in parallel arc. The first resistance measured is that of the leading wire alone, and the second resistance is that of the line and leading wire together. The little calculation to be made in order to derive the true resistance of the line from these two measurements will be easily seen by reference to the conductivity of the respective circuits. It will be remembered that the term conductivity is used to express exactly the opposite property of resistance, Sir William Thomson having introduced the term "mho" for the unit of conductivity, which is taken as the exact reciprocal of one "ohm," and, in fact, is that word (or rather name) spelt backwards. The term, as far as use is concerned, is not in everyone's mouth just yet, the idea of resistance having such a deeply-rooted hold of us all; but the *idea* of conductivity lends itself very conveniently to the consideration of resistances in parallel, for we know that in this combination the total conductivity is simply the sum of the conductivity of each, and the reciprocal of the total conductivity gives the joint resistance of the whole. In the above case we require to know the resistance of the line alone. Now we can easily find the *conductivity* of the line alone by subtracting the conductivity of the leading wire from that of the leading wire and line. The resistance of the line alone is then found by taking the reciprocal of its conductivity. *Example*:—A line wire is connected by a leading wire to a testing room, its other end being "freed," and a test for insulation gives 350,000 ohms; the leading wire is then disconnected where it joins the line, and

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a second test gives one megohm (10^6 ohms). What is the insulation resistance of the line?

$$\text{Conductivity of line and leading wire} = \frac{1}{\cdot 35 \times 10^6} \text{ mhos.}$$

$$\text{Conductivity of leading wire alone} = \frac{1}{10^6} \quad "$$

$$\text{Therefore, conductivity of line alone} = \frac{1}{\cdot 35 \times 10^6} - \frac{1}{10^6} \quad "$$

$$= \frac{\cdot 65}{\cdot 35 \times 10^6} = \frac{13}{7 \times 10^6}$$

and the resistance of the line is the reciprocal of its conductivity—viz., $\frac{7 \times 10^6}{13} = 538{,}000$ ohms.

80. The points in which improvements have been attempted in the construction of the current indicator or detector have been chiefly the following:—

1. Reduction of the friction on the moving needle to a minimum, doing away with irregularities in the relation between currents and deflections, due to variation of friction, and rendering the instrument more sensitive.
2. Protection of bearings and needle spindle points or pivot points while the instrument is subjected to shaking and otherwise knocking about in transit.
3. Best method of winding the coil to give maximum effect when occupying a given volume.
4. Facility of reading quickly and accurately the deflections.
5. Easy accessibility of all parts of the apparatus for purposes of cleaning or adjustment, if required.
6. Sensitiveness, or variation of deflection for slight changes in the current.

An instrument combining portability with the above conditions being a great requisition to the ordinary battery and

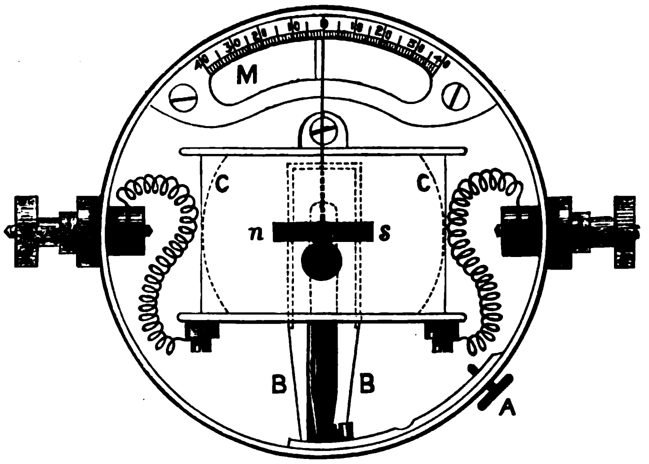

Fig. 44.

line testing at the General Post Office, a great deal of attention has been brought to bear upon its improvement by Mr. Preece and Mr. Kempe, in conjunction with Mr. Eden, with the result that a "standard" form has now been evolved as the "survival of the fittest" of all their experiments and trials. This instrument is illustrated in plan in Fig. 44, and in elevation in Fig. 45, the cover in this figure being removed and the needle support withdrawn from inside the coil. The needle itself is shown in Fig. 46, and is a very light steel magnet of the shape *n s*, to which is affixed a brass cap, C, holding at its centre the sapphire cap which rests on the pivot point when the needle is in position. The pointer *p*, at the extremity of which the readings are taken, is a rigid and light strip of ebonite fixed at right angles to the needle, and the weight *w* of the same material serves to balance the needle in a horizontal position. In both the other figures the movable brass slide B, on which is fixed the upright steel pivot to carry the needle, is shown. This slide containing the needle is easily inserted into or withdrawn from the coil, its movement being kept rigidly in one direction by its bevelled edges sliding in guide grooves cut along the interior of the brass bobbin. A slight projection on the slide seen in the figure fixes the limit to which the slide can be pushed into the coil, and insures the needle always being in the centre of the coil. The steel pivot point is finished with great care, being carefully examined under the microscope during manufacture, the sides converging towards the point in as nearly as possible the curve of a parabola. Protection of the point when the instrument is not in use is secured by raising the needle from off it by means of the lever

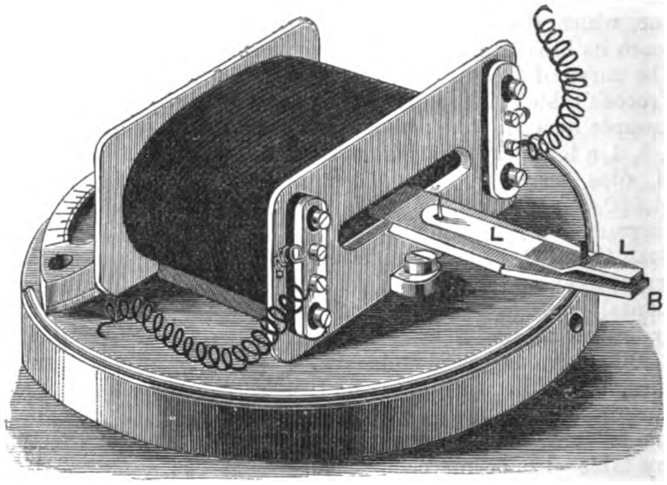

Fig. 45.

L L. It will be easily seen that by depressing the short end of this lever the other end lifts the needle off the pivot, and it is arranged that the downward play of the short end (effected by moving the screw head A sideways to the left) shall be just sufficient to raise the needle through the requisite distance to bring its cap into close contact with the top of the interior of the brass bobbin, thus preserving it completely from move-

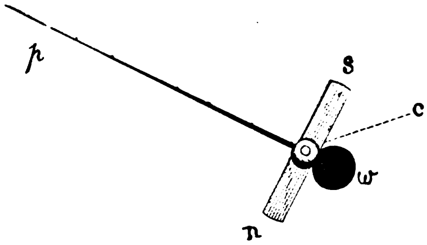

Fig. 46.

ment during transit. The dotted lines in the centre of the coil in Fig. 44 show the needle mounted in position. Its point then rests over the divided scale, attached to which is a mirror, M, the purpose of which in instruments of this class is to avoid the error of "parallax" while reading the deflections. This error will always be more or less introduced according as the point of the needle is at a greater or less distance from the scale when the direction of the line of sight from the eye of the observer to the needle is not always constant. By means of the mirror (attached to all accurate instruments), the reflected image of the needle is visible in the mirror, and the reading on the scale is not taken until the needle is seen to exactly cover its own reflection therein. In order to throw as much light as possible on the scale and needle, a glass window is let into the side of the brass cover opposite the scale, and the top of the cover being of glass, there is every possible facility for very accurate readings. It is seen, therefore, that conditions 1, 2, and 4 are complied with. The third condition is carried out by Mr. C. J. Simmons, of London, the maker of the instrument, by "grading" the wire composing the coil, and giving the outside contour of the coil the shape of the curve indicated by the dotted

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lines *c c*. When the size of the coil—that is, the space to be occupied by the wire—and its required resistance have been once fixed upon, it has been pointed out by Sir William Thomson that the maximum magnetic effect, or, what is the same thing with the same current strength, the maximum number of *turns* of wire, can be wound into the allotted space when the wire is graded in sections of different diameter. That is, the winding is commenced nearest to the needle by fine wire, a certain portion of the available space being filled up with this winding. Then a wire of larger diameter is jointed on to this and the winding continued. This is done for three or four different sizes of wire, all being calculated at first so as to add up to the required resistance when completely wound on. In this instrument the wire is graded three times, the final resistance being 800 ohms. The shape of the exterior of the coil is also a matter of consideration, and the same authority gives it as the most effective winding for the coil of a current indicator or galvanometer when the greatest number of turns of the wire are wound near to the needle when at rest—that is, at right angles to the axis of the coil—the shape of the curve itself being accurately expressed for coils whose turns of wire are in circles by a mathematical equation.

The fifth condition is ensured very effectively as regards the accessibility of the needle, this having already been shown. The ends of the coil go to separate terminals on an insulated brass plate, two other terminals on which serve to connect a short spiral of thick wire to the instrument terminals, in the usual way. The finish of the instrument, as turned out by Mr. Simmons, is excellent, the G.P.O. having relegated all their old astatic forms of indicator to this maker to convert into the "approved converted form," with the parts somewhat similar to the above. The instrument which has been described above is not "astatic." An instrument is said to be astatic when it is provided with two parallel needles mounted on one spindle, and turning together, one being inside the coil and the other outside, and the opposite poles of the two needles pointing the same way. By this device the controlling force of the earth's magnetic field upon the needle which tends to draw it towards the magnetic meridian when it is deflected away from it by a current is almost entirely done away with, only sufficient difference between the magnetic moments of the two needles existing necessarily in order to keep the needles at zero when no current is passing through the instrument coil. The writer has taken a "calibration curve" of the instrument described above, and finds that there is a "straight line law," or proportionality, between currents and corresponding deflections up to an angle of 27deg., this being nearly the whole length of movement of the needle, which, owing to the construction of the coil, is limited in its movement to 35deg. In the following chapter the calibration of current indicators will be considered, with the plotting of curves exhibiting the relations between the strength of the current and the angular movement of the needle.

(To be continued.)

SAFETY LAMPS IN COLLIERIES.*

BY W. H. PREECE, F.R.S.

On a fine summer's day the sun expends an average of one horse-power on every 30 square feet of the earth's surface in this latitude, or 1,450 horse power per acre. This great gift of energy is neither utilised nor stored by man at present, though Nature presents us with some of it in waterfalls and flowing streams. The sun itself has been more generous. Ages upon ages ago it shone with resplendent glory on a grand luxuriant flora of a uniform but flowerless character in a climate warm and damp. England formed part of a tropical jungle or swamp, where grasses, mosses, ferns and sedges, *coniferæ*, *araucariæ*, *equisetæ*, *sigillariæ* grew and flourished, perished and fell *in situ*, to be covered up by following geological formations and compressed into those grand seams of coal that form now the principal source of England's greatness and wealth. If language be fossil poetry and words condensed history, then coal may be derived from *coelum* or *κοιλος*, and imply a Heaven-sent gift.

The first authentic account of coal digging dates from the reign of Henry III., when Newcastle sent its first cargoes by sea to London, and thus gave the mineral the name of *sea-coal*. Early records of the output of coal are wanting.

In 1700 it was 2,614,000 tons.
In 1800 it was 10,000,000 tons.
In 1850 it reached 42,000,000 tons.
In 1886 it reached 157,518,482 tons.

A ton of coal occupies very nearly a cubic yard of space. Hence this quantity of coal, if placed in Hyde Park, would form a mountain as high as Snowdon, and if erected as a wall around the coast line of Great Britain, it would be 6ft. wide and 30ft. high. It would form a girdle round the world 3ft. wide and 12ft. high. We extract from the earth twenty times more energy than the sun can possibly restore to it by the growth of forest, and we are gradually but surely tending towards the time when this store of power, heat and light will be exhausted, when our busy hives of industry must seek other shores, and when England will perhaps become a summer resort for a wealthy Anglo-Saxon race occupying other quarters of the globe.

Coal is not only, like knowledge, power, but, like the precious metals, it is wealth. The average price of coal at the pit's mouth in 1886 was 5s. per ton, and thus its total value was £40,000,000, but when we consider the average price paid for it, we must double, if not treble, this lump sum. The number of collieries open was about 3,500, and since it costs £100,000 to open a colliery 2,000ft. deep, and when we think of the railways, the canals, the ships, the shops, the marts employed for its transit and its distribution, we can only conclude that the capital embarked in this industry must equal, if not exceed, the National Debt.

The hewing and raising of coal is unquestionably a dangerous occupation. "The price of coal is pit-men's lives," said an old collier to George Stephenson. 520,000 persons are employed in our collieries, and the output per person is 308 tons. 953 persons met their deaths in 1886; but it is satisfactory to know that a miner's life is more than twice as safe now as it was thirty years ago.

The number of persons employed per death was—

In 1856	242
In 1886	545

The number of tons raised per life lost was—

In 1856	64,700
In 1886	188,800

Most people, if asked what was the principal cause of this loss of nearly 1,000 lives, would answer explosion of fire-damp, but this would not be true. The principal cause of accident is falls of roof and sides. In 1886 there were from—

Falls of roof and sides	461 deaths.
Explosions	129 „
Trams and tubs	81 „
Miscellaneous	282 „

Thus falls of roof form 41 per cent. of the whole, and explosions 23 per cent.

Explosions attract immense attention, from their publicity and their appalling suddenness and magnitude. It is dreadful to take up a morning paper and read of 268 fellow creatures engulfed, as at Abercarne in 1878, or 164 at Seaham in 1880; but the daily and steady loss of life by ones and by twos fails to get chronicled, and passes unheeded by with the very great majority of the 20,000 violent deaths that occur in these islands every year.

In order that you may see how coal is won and hewed and raised, how dangers are incurred and surmounted, I will take you into a coal mine—one of the Cannock Chase Collieries of Staffordshire—by aid of a beautiful series of photographs, taken by means of magnesium light by my friend Mr. Arthur Sopwith, the eminent manager of those mines.

[A series of 27 photographs were exhibited.]

* Paper read before the Royal Institution, February 10th, 1888.

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I have shown you most of the operations connected with the winning and working of coal; some of the risks the miner incurs; some of the troubles arising from gas, water, and falling roofs; and one of the modes of producing ventilation—the chief prevention of accident. What our mines could have been in days gone by it is impossible to conceive; now mechanical appliances are so admirable that many mines are as perfectly ventilated as our homes. The temperature below ground is so uniform—50deg. F. at 50ft., and rising 1deg. for each 55ft.—the formations sometimes so dry, that I have actually heard it proposed to establish a sanitorium for consumptive patients underground, lighted by electricity, and supplied with every luxury.

All mines are required to have two shafts—one the *intake* or down-cast, the other the *return* or up-cast, and as the workings are so interlaced with ways and roads, doors are inserted here and there to direct the current, anemometers are used to measure its rate of flow, and any ordinary inroad of gas is swiftly swept away. Fire-damp, or pit gas, is marsh gas ($C H_4$). It oozes out gently from the exposed seam, or sometimes it bursts out through some fissure with great force, forming what are called "blowers." If it be mixed with air, in the proportion of from 5 to 9 per cent. of gas, it becomes highly explosive, and is the prime cause of those fearful disasters that have made coal mining so terrible.

In gasless mines candles always have been and still are used, but in early days, in foul places, men had frequently to work in the dark, or to be content with the feeble illumination of the phosphorescence of decaying fish. It is remarkable how the eye adapts itself to feeble light, and in the Cimmerian darkness of a coal mine even phosphorescence has a useful illuminating effect. In many places they used the *steel mill*, a disc of steel rotated rapidly against flint, giving light by the shower of sparks thrown down. It is most remarkable that no scientific thought was devoted to this subject until 1815. In 1813 Dr. Clanny, of Newcastle, had devised a very poor lamp, the air to support which was driven by bellows through water; but in 1815 Sir Humphrey Davy devoted his powerful mind and skilful hands to solve the question, and speedily invented in this very Institution his immortal safety lamp. It is a remarkable coincidence that in the same month another powerful but untutored mind, by strong observant powers and pure mechanical reasoning, had arrived at very nearly the same result; and even to this day the affectionate remembrance and name of the eminent Northumbrian brakesman, George Stephenson, is maintained by the use of the "Geordie," in his old home, the Killingworth Colliery.

Davy's classical paper was read before the Royal Society, on November 11, 1815, and was entitled "On the Fire-Damp of Coal Mines; and on Methods of Lighting the Mine so as to Prevent Explosion." He showed that flame would not pass through small tubes and apertures, and how in comparatively still air, however charged with gas, a wire gauze surrounding the flame so reduced the temperature by radiation that explosion was impossible. Ingress of air and egress of products of combustion are resisted. He showed that a flame so protected gave immediate intimation of the presence of gas by burning dimly, and by becoming capped with a blue flame, or *aureole*, that though the wire gauze became redhot, it still radiated away the heat sufficiently to prevent its reaching the temperature point of explosion. He also pointed out, which has been strangely neglected, until enforced recently by the Royal Commissioners on Accidents in Mines, that it failed to act in a current of air, but that this effect of currents could be diminished by shielding or protecting the inlet of air.

The main principle discovered by Davy is the basis of all safety lamps burning oil or spirit, but several departures in form have been proposed at different times. The "Geordie" is in reality a Davy lamp with a glass shield. The "Jack" lamp is a Davy in a tin can. The "Clanny" is a Davy lamp with the flame portion surrounded by a thick glass cylinder to increase the emission of light, and now with a bonnet or shield to protect it from currents of air. The "Mueseler," or Belgian type, is a "Clanny" with a central metallic cone acting as a funnel to increase the draught, and therefore the light. The "Marsaut," or the French type, is a bonneted or protected "Clanny," with two and three gauzes added to increase the security. The number of lamps is legion. A new intake here, a fresh egress there, a new direction to the currents of air feeding the flame, a change in the form or character of the wick, a lock, a different form of pricker, a shut-off or extinguisher (automatic or manual), is quite sufficient to justify a new patent and a new name. The Royal Commission experimented upon 250 different kinds of lamps.

Since the commencement of the year a new Act has come into force rendering it unlawful to use the plain "Davy," "Stephenson," or "Clanny" lamp in mines where safety lamps are necessary. They must be shielded, and great numbers are being converted into bonneted "Marsauts" and "Mueselers." They are also being constructed to burn the best vegetable oil (rape or colza), to which one-third mineral oil is added, as recommended by the Royal Commission, to enhance the light-giving power of the lamp. These converted lamps have baffled all attempts to explode them in currents of explosive gases of very high velocity, and under the most rigid tests.

There are several objections to these oil lamps. They go out, or are put out when danger exists; they render that most important and essential duty, examination of the roof, difficult and insufficient. If they become extinguished by accident or design, much time is necessarily wasted in getting them relighted, an operation that must be done at or near the shaft, perhaps two miles away from the working face, and which therefore reduces the output of coal and the earnings of the collier. The light they give, even at the best, is very small—about one-third to half of a candle.

There are several dangers present. The Royal Commission said:—"The source of light within the lamp should be unable under any circumstance at all likely to occur in working coal to cause the ignition of an inflammable mixture of fire-damp and air, even when this is passing at a high velocity." But glasses break by water, heat, falling coal, and accident. Joints get loose and bad even when protected by asbestos washers. They prove a constant temptation to the thoughtless and callous to get a light. The perfect light does not exist at present, but while these mechanical lamps are very excellent in their way, electricity seems likely to step in and supply their deficiencies and fill a decided want. An electric lamp can be made to give any desired amount of light, and anything between half a candle and a candle seems easily attainable, while such a light can be maintained steady and bright in explosive gases and in strong currents of air. They are simple in construction, easy of inspection; they are not likely to be extinguished in handling like the Mueseler; but they do not act as detector of the presence of gas, and they might explode gas if their protecting glass shield were accidentally broken.

It is remarkable that Davy himself in 1815 experimented with an arc lamp in a closed vessel of glass, but it was not until 1865 that a practical lamp was proposed for collieries. Dumas and Benoit used a small Geissler tube illuminated by sparks from an induction coil and excited by a primary battery; but it was heavy—it was a kind of knapsack to be carried on the back, and it met with no success.

Mr. Swan has been more successful. The great success of the glow lamp, in the introduction of which he has played so prominent a part, and the perfection of the secondary battery have enabled him to produce a lamp that compares in weight and size and light with the best mechanical lamp. Eight hundred of these lamps are in constant use in the National Colliery in the Rhondda Valley in South Wales, and 1,600 more are on order for the Risca and Abercarne Collieries belonging to Messrs. Watts, Ward and Co. They are giving great satisfaction. A collier told me that the electric light was "as good as the moon." The lamp batteries are charged a great number at a time in blocks at the pit bank.

Mr. Pitkin has also been very successful in making light portable lamps, and they have been practically used at Cannock Chase and at the Tyldesley Collieries in Lancashire.

The "Sun" lamp is another very promising form, worked by secondary battery. It is light—3lbs. 12oz.; it gives

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1¼ candle, and this is maintained for 10 hours. Secondary cells usually require about 12 hours' charge to emit a 10-hour discharge, but this cell will give a 10-hour discharge with 4 hours' charge. It is fitted with a safety appliance—a plan patented by Mr. Sennett in 1882—by which the lamp is automatically switched out the instant that the outer protecting glass is broken or cracked, so that contact between the hot filament of the lamp and the explosive gas is prevented. This safety appliance has been tested by Mr. Rhodes at the Aldwarcke Colliery in actual explosive mixtures.

Many efforts have been made to introduce primary batteries for the same purpose, but up to the present moment I have seen only one—the Schanschieff—which, in efficiency, lightness, and economy, comes up to the requirements of a safety lamp. A primary has this advantage over a secondary battery—that it is charged at once by an operation as simple as that of trimming a Davy. To trim a Davy means thorough cleaning, inserting a fresh wick, pouring in new oil. A primary battery means pouring out old and pouring in fresh solution.

Occasionally zinc requires renewal, but all these operations are within the intelligence of the collier, and the lamps need not go to the surface. The simplicity of the operation has distinct merits of its own that compensate for the extra cost of the materials used.

The chief charm of the electric lamp is not the greater light that it gives but the power it gives the viewer to examine the roofs of the ways and workings; it is so extremely portable and handy; it can be put anywhere; the battery can be placed on the ground or suspended by a spike to a tree, and the lamp can be fixed in the cap or around the waist; it can be put anywhere and used anyhow.

Mr. Sopwith, at Cannock Chase, has been taking heavy batteries to the working face, and using bright 8-candle lamps in reflectors, so as to illuminate the working face with a light which in that region is comparable to daylight. The men are charmed with it.

The chief defects of the electric lamps are their fragility, the liability of the carbon filament to break, the weight of the battery, and the absence of gas detection; and these defects have been very much enhanced by imperfect construction and injudicious details. Electricians have not spent sufficient time in the lower regions, and practical colliers have no time to go to the laboratory. When the two professions are properly amalgamated we shall very likely obtain the true safety lamp.

The electric lamp is not a fire-damp detector, but an electrical appliance is easily added. Liveing and Swan have done this; but it is doubtful whether a more efficient detector than the Davy exists, and whether an apparatus that is so thoroughly understood, and so thoroughly practical, will be superseded for a purpose for which it seems so eminently adapted.

I cannot conclude, especially in this place, with more pregnant words than Davy's own:—"The gratification of the love of knowledge is delightful to every refined mind; but a much higher motive is offered in indulging in it when that knowledge is felt to be practical power, and when that power may be applied to lessen the miseries or increase the comforts of our fellow creatures."

INSTITUTION OF MECHANICAL ENGINEERS.

THE POSITION AND PROSPECTS OF ELECTRICITY AS APPLIED TO ENGINEERING.

BY MR. W. GEIPEL

(Concluded from page 357.)

Storage Batteries.—Storage batteries on the car have not as yet been much used, though many experiments have been made from time to time. The problem was first attempted by Mr. Reckenzaun, who has done much to perfect the plan.* The difficulty is that, if the accumulators are made light, their depreciation is high, while if they are constructed with a thoroughly serviceable make of cell, their weight is very great. The first cost of the cells is also somewhat prohibitive, and their depreciation is high. A trial of this plan on a practical scale is now being made by Mr. Elieson on the North Metropolitan Tramway in London.* The storage cells are placed on a separate locomotive car. The motor turns itself round on an upright pivot by means of a bevel wheel on the armature shaft, gearing with a circular rack fixed on the floor of the car, and the revolution of the motor is transmitted to the axle of the car through mitre gear. The plan has been unsuccessful in the past, owing to the use of inefficient motors and gear, which require of course an increased size of battery in proportion to their inefficiency; the imperfection of the secondary batteries employed, as pointed out, has also prohibited success. With motors, speed-reducing gear and secondary batteries all improved, the experiments now being made bid fair to demonstrate the successful working of tramways by electricity in crowded thoroughfares.

* See *Electrician*, Sept. 23rd, 1887, p. 426.

Ordinary Rails as Conductors.—The short electric railway of Mr. Volk at Brighton† on this system is interesting as being one of the earliest in use in this country. The expenses amount to 2d. per car-mile, being made up as follows:—

	Pence.
Gas for engine	1·11
Wages	0·70
Oil and waste	0·07
Repair	0·12
Total per car-mile	2·00

The total car-miles per annum are stated to be 47,000, and the depreciation at 10 per cent. on the £3,000 cost of construction is, therefore, equal to 1½d. per car-mile, thus bringing up the total cost to 3½ pence per car mile. Several similar railways are now working or contemplated in seaside towns.

Cost of Working.—From these instances it will be seen that, taking into consideration the fact that the machines here employed are not so efficient as those now being made, an electric tramway may be worked for about threepence per car-mile, and as the cost of horses is from sevenpence to ninepence per car-mile, the importance of electric propulsion for tramcars and short railways is very evident. At the Antwerp Exhibition in 1885, when electric locomotion was beginning to receive consideration in its commercial aspect, a series of trials extending over four months on five different kinds of tramway motors resulted in the first place being assigned to the electric car, in competition with the four following plans:—The Krauss and the Wilkinson locomotives separated from the car, the Rowan engine and the car combined, and the Beaumont compressed-air car. The results of these trials are given in the following table:—

Trials of Tramway Motors at Antwerp Exhibition, 1885.

Description of motor		Electric	Rowan.	Wilkinson.	Krauss.	Compressed Air.
Train-miles run, total		2,359	2,617	2,473	2,458	2,259
Consumption of fuel.	total......lbs.	14,786	14,498	22,000	22,726	90,420
	per train-mile ...lbs.	6·16	5·42	8·82	9·10	39·48

Notwithstanding that the use of electricity for heavy railway traffic has been predicted, the author thinks that, so long as the electricity is generated by dynamos driven by steam engines, steam locomotives will not be discarded in favour of electricity for long distances. But for light railways and suburban lines, underground or overhead, where the use of a steam engine is a nuisance, there can be little doubt that electricity must be largely adopted in the immediate future, as the number of such railways already constructed and in course of planning is now between one and two hundred

Telpherage.—The plan of transporting material in skips on overhead wire-ropes by means of electricity, introduced under this name by the late Prof. Fleeming Jenkin,‡ of Edinburgh, has not so great a field for its use in this country as it may have in less populous regions, because our roads are good, and railways generally near at hand, and we have abundance of water carriage. But in places where material has to be conveyed across hilly districts or over bad roads to the railway or water it will be found more useful. It has been employed with considerable success for the past two years at Glynde§ near Lewes for transporting clay to the railway over a distance of 1,600 yards; 270 tons are carried weekly at 7½d. per ton. In our larger cities a modification of this plan might advantageously be applied to alleviate the heavy

* See *Electrician*, Oct. 21st, 1887, p. 495.
† See *Electrician*, Sept. 1st, 1883, p. 368.
‡ See *Electrician*, Nov. 3rd, 1883, p. 589.
§ See *Electrician*, June 17, 1887, p. 122.

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street traffic. In the place of wire-ropes, stiff girders might be used, the cars being suspended from wheels running along a rail or rails fixed on the girder. Such a railway would be economically constructed, in comparison at least with the expense of constructing an underground railway; and it would not have any great effect in obstructing the light from the streets, as is the case with elevated railroads for steam locomotives.

III. Electric Lighting.

Of the four branches of electric engineering dealt with in this paper, electric lighting is the one which up to the present has received most attention, called forth the largest outlay of capital, and produced the most beneficial results, if not to so great extent in this as in other countries.

In incandescent lighting, the cost of distribution is still heavy, though by increasing the electromotive force and the efficiency of lamps it is being much reduced. In arc lighting, the difficulty of subdividing and of reducing the amount of light given by one arc lamp renders it expensive for general out-door street illumination, as compared with the present low prices of gas and oil. For the lighting of main streets and railway stations, or other places where a concentrated light is required, the arc light is beyond question far cheaper than gas; and its cost per candle-power is but a very small fraction of that of gas. As the use of electric lighting extends, the cost of working becomes reduced; installations which four years ago cost fourpence per arc lamp per hour are now costing only twopence. The chief saving has been in the items of carbons and attendance, though the increased efficiency and durability of the apparatus have also greatly contributed to the reduction; four years ago 11mm. or 0·43in. hard carbons cost 4d. per foot; they can now be obtained for 1½d. per foot, or less than one-third.

The following figures supplied by the North British Railway respecting the actual cost of working their electric lights at the Waverley Station, Edinburgh, are interesting as showing how much cheaper it is becoming. The installation is worked by their own staff, and consists now of forty Brush arc lamps, supplied with a current of 10 amperes by a No. 8 Brush dynamo, which is driven by a semi-fixed engine:—

July to December, 1884, thirty-three arc lamps, 41,884 lamp-hours.

Wages	£165	13	9
Repairs	47	2	6
Carbons	125	15	11
Coal	65	19	11
Oil, stores, &c.	27	15	0
Interest and depreciation at 10 per cent.	52	2	2
Equal to 2·77 pence per lamp-hour.	£484	9	3

July to December 1886, thirty-nine arc lamps, 55,068 lamp-hours.

Wages	£195	17	6
Repairs	78	9	6
Carbons	62	17	3
Coal	23	14	1
Oil, stores, &c.	8	15	2
Interest and depreciation	41	10	6
Equal to 1·79 penny per lamp-hour	£411	4	0

In conjunction with these arc lamps they are running 148 Brush Victoria incandescent lamps, distributed in the refreshment and waiting rooms, and throughout the whole of the suburban station. For these the total number of lamp-hours for the half-year was 171,251, and the cost was £83. 9s. 9d., including all contingencies, equal to 0·12 penny per lamp-hour. There were 113 lamps renewed, which shows an average life per lamp of 1,515 hours.

Local Conditions.—The cost of incandescent lighting is especially variable, and affected by the local conditions of the installation. The chief of these are (*a*) the average number of hours of lighting each lamp, and (*b*) the average distance of the lamps from the generating station. Where the conditions are favourable, incandescent lighting can already compete with gas; and in a number of installations which have been superintended by the author a large saving is being effected. The following figures kindly supplied by Messrs. George Jaeger and Son show that the yearly cost of lighting their sugar refinery at Leith has been reduced from £347 with gas to £204 with incandescent lamps. The average life of the lamps is about 1,400 hours each. The installation consists of 180 Brush Victoria lamps of 17 and 10 candle-power, supplied by a self-regulating Victoria dynamo, which is driven off the shaft that drives the centrifugal drying machines. The dynamo has been running night and day since it was started two years ago, without failure. It is started on Monday morning, and runs continuously without stoppage till the following Saturday afternoon.

Previous average cost of gas lighting per annum.	£332	13	4			
Part of plumber's time	15	0	0			
				£347	13	4

Cost of Electric light, May, 1886, to May, 1887.

Lamp renewals	£46	9	8			
Oil, waste, sundries	17	5	0			
Coal at 3lb. per horse-power per hour, 40 tons at 6s.	12	0	0			
Repairs, including men's time attending dynamo	36	5	3			
Depreciation at 10 per cent.	33	16	0			
Gas consumed on Sundays, and when engine is standing	58	4	5	204	0	4
Saving per annum by electric lighting				£143	13	0

In the United States there is hardly a city or town of 20,000 inhabitants which has not a central station for arc or incandescent lamps; and many towns of 3,000 or 4,000 are supporting them also. On the Continent large central stations for electric lighting are already in operation in competition with gas; but there the price of gas is generally two or three times what it is in this country.

If the power is to be generated by dynamos and used direct, the cost of distribution on a large scale will probably never be reduced as low as with the existing gas supply, seeing that an efficiency of 95 per cent. can now be obtained with the dynamo, and that steam engines are not likely to be materially improved. It is therefore in the lamps that improvement is to be looked for, by making them with a higher resistance and greater efficiency.

Transformers.—These are at present receiving a large amount of attention. By their means small high-tension currents of electricity, sent from a distant generating station along a small conductor with a comparatively small percentage of loss, can then be converted into large low-tension currents for the supply of ordinary incandescent lamps. In some arrangements of these transformers the loss in conversion is not more than 5 per cent. Unfortunately the alternating system, which has thus far been adopted, cannot be used with satisfaction for driving motors doing practical work or for charging storage batteries. The continuous current transformer has certainly the advantage in respect to the supply of power and to the charging of storage batteries; but it is a question whether the disadvantage of having to keep it continually in motion will enable it in town lighting to compete with the alternate-current transformer. The latter is employed in the Grosvenor Gallery central station in London. Some idea of its importance may be formed from the fact that the Westinghouse Company have already in America over 100,000 lamps at work on this system, although it is not yet so much as two years since they adopted it. Notwithstanding that the use of transformers enables a great saving in copper to be effected, more especially where the lamps are scattered, as in suburban districts, yet it is to be remembered that the insulation of underground conductors forms a very important item in their total cost. The installations already at work are all worked with overhead conductors, with the one exception at Eastbourne; so far as the author is aware there are no practical data to establish the general applicability of the transformer system for the lighting of large and thickly populated towns where underground conductors may alone be tolerated.

Secondary batteries charged in series by a high-tension current and discharged in parallel circuit have been tried experimentally; but their practical application is not known to the author. At the same time, now that transformers are becoming more used, strenuous efforts are being made to introduce this system of secondary batteries, and if it can once be demonstrated to be economical, there can be little doubt that it would have a large field of application. Its great merit is of course the reduction of risk of the light failing.

It should be borne in mind by electric light companies that the supply of incandescent lamps is not to be their only source of revenue; but as already pointed out, the supply of current should be of such a nature that it may be employed for as many purposes as possible. By the use of efficient boilers and engines and properly constructed continuous-current dynamos, a central station can be so constructed as to be no nuisance whatever, provided proper precaution be taken in selecting the site. In large towns it will not be necessary to extend the conductors very far before a demand will be met with sufficient for occupying an engine large enough to be economical. Above a certain size the cost of working a steam engine becomes practically constant for any increase in size; so that, instead of working from one large central station over a very large area, it is found better to work from smaller stations over smaller areas. The cost of attendance will thereby be increased to only a small extent, because one man cannot fire more than two boilers; therefore, when more boilers are required, it is preferable to work them at another station with another fireman. At Leamington an extensive central station is now at work, and the cost of the undertaking is about £30,000. The Bradford Corporation have recently voted a sum of £15,000 for erecting a central station in their town. Both of these are instances of direct supply, without transformers or secondary batteries.

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IV. ELECTRIC METALLURGY.

This branch of electrical engineering bids fair to become speedily of the highest interest to engineers. The electro-chemical separation of ores on a commercial scale by the electric furnace has but recently been put to the test, chiefly in obtaining aluminium from corundum, its richest ore. Sir William Siemens first turned his attention to the subject, but his death occurred before he had perfected his invention. It was taken up by Messrs. Cowles, who with the assistance of Prof. Mabery have devised a furnace, in which by the passage of powerful currents the refractory ore is successfully reduced.* The furnace is built of fire-brick, and lined with powdered charcoal to withstand the intense heat. It is in the form of a box, 5ft. long, 12in. wide, and 15in. deep. Current is conducted through the walls and into the ore by means of a number of carbon rods 3in. diameter, and from 2 to 3ft. long. The positive and negative carbons are introduced from opposite ends, and nearly meet in the centre. The ore, mixed with charcoal and granulated copper, is put in so as completely to surround and cover the carbon. The furnace thus charged is closed with a layer of charcoal and a lid lined with firebrick; without the protection of some such refractory material as charcoal the intense heat causes the firebricks to run. When the furnace is ready, the current with an electromotive force of 50 volts is turned on, and is gradually increased up to some thousands of amperes. In a few minutes the metal is melted around the electrodes; and these are then moved farther apart, until the current passes through the entire charge, and the whole is in a molten condition; the corundum becomes gradually deoxidised, the aluminium combining with the copper, while the oxygen with the carbon escapes as carbonic oxide; about five hours suffice to complete the reduction. Current was supplied by large Brush dynamos, which were specially constructed for the work, and is capable of giving out 300,000 watts, or over 400 electrical horsepower. Its weight is nearly 10 tons; 5,424lb. of copper are wound on the field-magnets, while the armature has 825lb. of copper on it. Works already in operation at Lockport, U.S., have a capacity of 6,000lb. per day, and the cost of the aluminium-bronze so made is expected to be less than 1s. 8d. per lb., while Mr. Cowles anticipates the price being reduced to 8d. per lb. Works have also been started at Stoke-on-Trent, where a 500 horse-power dynamo has been fixed for generating the current; the potential is 60 volts.

Another electric furnace has been devised by Dr. Kleiner, of Zurich, in which cryolite, a double fluoride of sodium and aluminium, is similarly treated.

When it is remembered that the metal aluminium, in addition to many other good qualities, possesses great strength with only one-third the weight of iron, the importance of obtaining it at a reasonable cost will be readily appreciated; it would undoubtedly cause a great revolution in engineering construction.

The process of welding by electricity, introduced by Prof. Elihu Thomson,† is similarly based upon the passage of a powerful current between two electrodes. In this case the two pieces of metal to be welded form the electrodes; they are brought together into close contact, and as soon as the current is sent through the joint its resistance causes intense heat until the weld is perfectly completed. The process is almost instantaneous, and the heating occurs only at the joint; tempered steel can thus be welded without in the least affecting its hardness.

Another plan of electric welding has been introduced at St. Petersburg by Dr. Benardos, in which the heat necessary for fusion is caused by an arc. The current is conducted to the weld by means of a carbon rod, which is connected by a flexible cable with the positive terminal of a dynamo or battery, while the metal to be welded is connected with the negative terminal. The action of the arc set up by the flow of current from the carbon to the metal may be likened to that of the blow-pipe flame, except that the heating is more intense and sudden, and is therefore more local. The reducing action brought to bear on the metal keeps it clean and unoxidised.

[We shall next week give a full report of the discussion on this paper.]

* See *Electrician*, Oct. 22nd, 1886, p. 486, and Nov. 4th, 1887, p. 537.
† See *Electrician*, Sept. 17th, 1886, p. 392.

Errata.—We are requested by Mr. Kapp to correct two typographical errors in the proof of his paper read last Thursday at the Society of Telegraph-Engineers and Electricians. These errors occur in our reprint on page 339 of the last issue in the list of symbols. Instead of $e = \sqrt{E}$, read $e = \frac{E}{\sqrt{2}}$, and instead of $i = \sqrt{I}$, read $i = \frac{I}{\sqrt{2}}$. The exponent in the formula for E lower down the column should be $^{-8}$, and not $^{-3}$.

BOOKS, &c., RECEIVED.

"Electrical Instrument-Making for Amateurs: a Practical Handbook." By S. R. BOTTONE. (London: Whittaker and Co.)

"Voltaic Electricity." By THOMAS P. TREGLOHAN. (London: Longmans, Green and Co.)

"Map of Metropolitan Railways, Tramways, and Miscellaneous Improvements, deposited at the Private Bill Office for Session 1888."

MEETINGS OF SCIENTIFIC SOCIETIES.

TO-NIGHT (FRIDAY), February 17th.

ROYAL INSTITUTION.

9 p.m. Lecture, "Developments of English Pottery during the last 50 years." By Sir HENRY DOULTON.

SATURDAY, February 18th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Experimental Optics" (5). By Lord RAYLEIGH, M.A., &c.

MONDAY, February 20th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II. "Yeast, its Morphology and Culture" (4). By Mr. A. GORDON SALOMON, F.C.S., F.I.C.

INVENTORS' INSTITUTE.

8 p.m. Ordinary Meeting.

TUESDAY, February 21st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed, "The Economic Use of the Plane-Table in Topographical Surveying." By Mr. JOSIAH PIERCE, jun., M.A., Assoc. M.Inst.C.E. Papers to be read, time permitting, "Manganese in its Application to Metallurgy" and "Some Novel Properties of Iron and Manganese." By Mr. R. A. HADFIELD, Assoc. M.Inst.C.E.

ROYAL INSTITUTION.

3 p.m. Lecture, "Before and After Darwin" (6). By Mr. G. J. ROMANES, M.A., &c.

WEDNESDAY, February 22nd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Technical Education Bill." By Mr. SWIRE SMITH. Chairman: Sir H. E. ROSCOE, M.P., F.R.S.

CITY AND GUILDS OF LONDON INSTITUTE.

7:30 p.m. Meeting of Old Students' Association. The following Papers will be read—"Artistic Electric Lighting." By Mr. HOWARD SWAN. "An Easy Method of Determining the Distribution of Current in Networks of Conductors." By Mr. W. E. SUMPNER, B.Sc.

THURSDAY, February 23rd.

SOCIETY OF TELEGRAPH-ENGINEERS.

8 p.m. Ordinary Meeting. "The Present State of Fire Telegraphy." By Mr. R. VON FISCHER TREUENFELD.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting. Paper, "On the Erection of the Superstructure of the Forth Bridge." By Mr. ARTHUR J. KNOWLES, B.A., Stud. Inst. C.E. Mr. BAKER, Member of Council, in the Chair.

ROYAL INSTITUTION.

3 p.m. Lecture, "Early Secular Choral Music" (3). By Prof. C. H. H. PARRY, M.A.

FRIDAY, February 24th.

SOCIETY OF ARTS.

8 p.m. Indian Section.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Supplemental Meeting for Students. Paper, "On the Erection of the Superstructure of the Forth Bridge." By Mr. ARTHUR J. KNOWLES, B.A., Stud. Inst.C.E.

PHYSICAL SOCIETY OF GLASGOW.

Paper, "Conservation of Energy." By Mr. J. MACK, M.A.

ROYAL INSTITUTION.

9 p.m. Lecture, "Westminster Abbey." By the Very Rev. Dean BRADLEY.

SATURDAY, February 25th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Experimental Optics" (6). By Lord RAYLEIGH M.A., &c.

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THE ATLANTIC CABLE RATES.

The announcement which we were able to make a short time ago that a conference of the Atlantic Cable Companies was about to be convened for the purpose of agreeing upon a uniform tariff has been confirmed by what has transpired at the half-yearly meetings held in the interval. At the Anglo-American meeting last week the chairman, although not very sanguine as to the result of the proposed gathering, expressed himself favourable to its being held and to the objects it is designed to accomplish. Both at that meeting and at the one previously held by the Direct Cable Company the shareholders were almost unanimously in accord with the directors; and with the exception of a few isolated suggestions for reducing the tariff still lower, for raising it very much higher, or for the adoption of preferential rates—all of which propositions were impracticable and not supported by any considerable body of shareholders—the prevailing opinion seems to have been that the present rate ought no longer to be maintained, and that the time has arrived for a joint arrangement, or at all events an amicable understanding, among all the competing companies to adopt a tariff at once uniform and profitable. The sixpence-a-word rate has been tried for two years over all the cables except one, the exception maintaining an independent rate just twice as high. It is notorious that the first-named rate has not been remunerative; and in spite of allegations to the contrary it is pretty obvious that under the circumstances the higher rate has not been remunerative either. A shilling rate has yet to be tried all round; but with the majority of the cables competing at half price it is not likely that one of them could derive much advantage from the experiment of being singular. Probably they have come to the conclusion that if the higher rate is to have a fair trial it must be adopted by all the competitors alike, and as the dissentient company has nothing to lose, but rather, one would imagine, something to gain by such an agreement, we entertain the belief that it will be shortly arrived at.

Leaving the one doubtful cable company out of account for

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the moment, its interests and policy being directed exclusively from the other side of the Atlantic, no one can reasonably urge that the English companies and their allies are not perfectly justified in the action they are contemplating. Whether the sixpenny rate was a fighting rate or a financial experiment is a point not now worth discussing. Whatever its object the public have had the advantage of it for two years past, and if the companies have reaped no advantage, but quite the reverse, they might not unfairly lay the blame on the public, if, indeed, blame must be attached to somebody. A great rush of business, as usual, followed immediately on the reduced rate, increasing for a time at a considerable pace; then the increase fell off until, in fact, it showed no more disposition to grow than does the business over lines on which very high rates prevail. This is the usual history of all premature and abnormal reductions—of all reductions, in fact, which are not the natural result of prosperity. The traffic increases, but so does the expenditure; and the result is that the original sacrifice is never recovered, the margin of profit gradually dwinding lower and lower. The one and only conceivable gain to be derived from these fighting experiments is that the area of business may be enlarged and custom secured that will not wholly disappear when the time arrives—as arrive it must—for reverting to normal rates which will pay the proprietors for their investment and risk. Even the shilling rate does not, or did not, answer this description, with several companies competing for traffic insufficient to employ more than two or three of them. But accepting the situation as it stands, and allowing for a permanent increase of telegrams due to the cheaper rate, the adoption of the shilling tariff is an experiment worth trying for a time, on the understanding that it may be further increased if the companies cannot get a living by it.

We have here distinctly asserted the companies' right to frame their own tariffs. This right can be challenged only in one of two ways, either by competition or by monopoly. Of competition in this quarter there has been more than enough to prove that it is simply suicidal. In the long run the public do not gain by it, for they have to support finally more cables than are necessary; in other words, they have to pay rates higher than would be needful if superfluous cables had never been laid. As regards monopoly, if the country had conferred any such privilege on the older Atlantic companies it would have imposed its own conditions; but having elected to allow free competition the public cannot now complain, whatever the consequences may be. And in point of fact we do not believe that the public will complain of any reasonable course which the existing Atlantic cable companies may find it their imperative interests to pursue. The public have always regarded the sixpenny rate as a temporary one, certain to be doubled or trebled when the competitors had adjusted their differences. Moreover, it is perfectly well known that the best customers of Atlantic telegraphy are not in love with cheap rates. What they want is a good service for important transactions; and they are willing to pay a fair price for it—a fact which is proved by one of the companies having kept up its rate, and done a good business at it. The science of coding, too, has risen to such perfection that whatever the rate may be the code user may be trusted to take care of himself. Lastly, the public, so far as Atlantic telegraphy is concerned, is a very limited public—the general public being concerned with it hardly at all. Domestic messages, such as swell enormously the bulk of inland telegraph traffic, and justify the reduction of its tariff to a popular figure, can hardly be said to have any existence in international telegraphy. It is a sufficient condemnation of the sixpence-a-word rate to America to point out that sixpence is the lowest payment for which we can dispatch a telegram across the Thames.

Notwithstanding these obvious and practical considerations, the irrepressible and irresponsible Mr. HENNIKER HEATON has publicly announced his intention of "rendering futile any attempt to raise the charge [for Atlantic telegrams] above 6d. per word." In his letter to *The Times* of Tuesday, where, after modestly insinuating that the "public ought surely to have a voice in the question of cable rates to America," he declares the subject to be of "such vital importance to the people" that he has prepared a letter to the POSTMASTER-GENERAL embracing the whole facts, the publication of which will checkmate these wicked companies. If the "public," as we have above shown, are little concerned with this subject, the "people" are still less so. But how about the POSTMASTER-GENERAL? We suspect that this high official has long ago taken the measure of Mr. HENNIKER HEATON, and will answer him as he deserves—if, indeed, a man who imagines the British POSTMASTER-GENERAL to have anything to do with the Atlantic cables deserves any answer at all. We for our part shall not attempt to argue with this colonial firebrand. He is the member for Canterbury, and if the "people" of that famous but rather somnolent city are interested in Atlantic cables, except as shareholders, the companies no doubt will be glad to hear from them. But he is more particularly a representative of the Australian colony—at all events, of one peculiar element in that colony—holding a brief, as we understand, against the existing cables which connect Australia with the mother country. We would advise him to stick to his brief, and not endanger his fees by interfering in matters for which, except by a spiteful construction, he has no commission whatever, and upon which this letter to *The Times* proves his incompetency to offer an opinion.

THE THERMO-MAGNETIC PROPERTIES OF IRON AND NICKEL.

BY HERBERT TOMLINSON.

The thermo-magnetic properties of iron have been studied even in the early infancy of magnetic science. Gilbert, the physician of Queen Elizabeth, found that a loadstone and piece of iron equally lost their power of affecting the magnetic needle when very hot, and that, whilst the magnetic property returned to the iron after it was cooled, the magnetic virtue of the loadstone was entirely destroyed. Gilbert's observations were confirmed by Brugmans, Boyle, Cavello, Barlow and Bonnycastle, Christie, Ritchie, Erman, Scoresby, Seebeck and others.* Faraday found that a steel magnet lost its permanent magnetism rather suddenly at a temperature a little under the boiling point of almond oil;† it behaved like soft iron till it was raised to an orange-red heat‡, and then it lost its magnetic susceptibility and became indifferent. The temperature at which permanent magnetism was lost varied with the nature and hardness of the steel; pieces of loadstone retained their permanent magnetism until just below visible ignition in the dark,§ but lost their susceptibility at a much lower temperature than iron. Nickel was found to lose its magnetic susceptibility about 330° C. to 340° C.‖ Cobalt was not deprived of its susceptibility at a white heat. The beautifully simple experiments of Dr. Gore have already been described in *The Electrician*,¶ and these have been extended by Baur** and Wassmuth. According to Baur, for

* See Prof. Chrystal's article on magnetism, *Enc. Brit.*

† The boiling point of bitter almond oil is 180° C.

‡ 1,150° C.

§ About 500° C.

‖ Bequerel about 400° C., Pouillet about 350° C., Chrystal (*Nature*, Vol. XXII., 1880), about 400° C.

¶ Vol. XX., Nos. 505-506.

** *Wied. Ann.*, XI., 1880.

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large magnetising forces,* the susceptibility decreases gradually until red heat, and then falls suddenly to a very small value. The same experimenter finds that if a bar be cooled from white heat, the first traces of susceptibility are observed at a very bright red, *the brighter the greater the magnetising force.*

Finally, we have the researches of Berson and Ledeboer, which have been already illustrated in *The Electrician.*†

The writer has, independently of Berson, drawn up thermo-magnetic curves for nickel.‡ These curves relate to *temporary* magnetisation, and in some respects agree with the curve temporary magnetisation drawn up by Berson. Thus the temperature of maximum sensibility is nearly the same, and the temperature at which the curve begins to slope down most rapidly, namely, 300° C, is the same. The temperature, however, at which the sensibility vanishes is higher the greater the magnetising force,§ the former ranging from 340° C. to 420° C., and the latter from 5 to 18 C.-G.-S. units. The temperature at which the metal loses all trace of susceptibility will probably also vary with the amount of annealing which it has undergone, and certainly varies with the purity, so that the widely different results obtained by different experimenters are not to be wondered at.

The most important point is the one at which the curve begins to slope down most rapidly, and this would appear to be nearly constant for different specimens of fairly pure nickel well annealed. The nickel should, however, be fairly pure, for the writer has in his possession a piece of nickel wire which has its magnetic susceptibility and most other physical properties nearly the same as that of pure nickel, but which, nevertheless, behaves as regards its thermo-magnetic properties like iron. The temperature where the most rapid slope begins is, for both temporary and total magnetisation, about 300° C., and if nickel be employed in the construction of a thermo magnetic motor the most advantageous limits of temperature between which the metal should be allowed to work would be 300°C. and 320°C. The writer has determined, from his own experiments on temporary permeability, the rate at which the number of lines of force would diminish with rise of temperature between the above-mentioned limits in a manner which will be understood from the following table :—

Temperature in deg. C. t.	Magnetising force in C.-G.-S. units. M_f	Temporary magnetic permeability. M_p	Difference between values of M_p at 300° C. and 320° C. divided by $\frac{\Delta M_p}{\Delta t}$.	$\frac{\Delta M_p}{\Delta t} + M_f$
300 320	4·959	141·0 96·6	2·22	11·1
300 320	11·571	95·5 73·8	1·08	12·5
300 320	18·183	84·8 69·1	0·79	14·3

This table furnishes important practical information, as it shows that we work with best advantage with comparatively low magnetising forces; in fact, we see from the fifth column that, with a magnetising force of about 5 C.-G.-S. units, we get for each degree rise of temperature a decrease of 11 lines of force per sq. cm., and with a force of 18 only a decrease of 14 lines.

The loss of magnetic susceptibility in nickel seems to be remarkably sudden in the case of a very thin layer of the metal, as the following experiment will show :—A brass wire 1mm. in diameter was coated with a thin layer of nickel by electrolysis, and a piece of it, about 2cms. in length, was suspended horizontally in a cradle of platinum between the pole-pieces of a powerful electro-magnet in a direction perpendicular to the lines of magnetic force; the platinum cradle was supported by a platinum wire 12 inches long and $\frac{1}{100}$th inch in diameter. The nickel-plated brass wire was heated by a burner to a temperature of about visible red, and the electro-magnet was then excited by five Grove's cells. Not the slightest effect of the intense field seemed to be experienced by the nickel, even after it had been cooling for several seconds. The magnetising circuit was now broken, leaving only the residual magnetism in the pole-pieces, when, after a few seconds of further cooling, and without *the slightest preliminary warning*, the piece set axially with startling suddenness.

The writer has also made experiments on the temperature at which iron begins to lose rapidly its magnetic properties, and from some investigations which he has made on the elasticity and internal molecular friction of iron at high temperatures,* he inferred that iron would begin to lose its magnetic properties at a temperature of about 550° C. The above estimate of temperature was only very rough, and M. Ledeboer's estimate of about 560° C. is probably nearer the mark for annealed iron; but it is evident from the experiments of Faraday and others quoted above, that the temperature of sudden loss of susceptibility will vary somewhat considerably with different specimens of iron and steel.† Whatever this temperature may be, however, there is an indubitably sudden change in the internal friction of iron in the near neighbourhood of it. Here the internal friction is at least six times as great as at a temperature of 20° C. and it goes on rapidly rising until there is another sudden jump somewhere above 1000°C., when the internal friction is more than twenty times as great as at 20° C. At the last critical temperature most extraordinary changes take place in iron; the metal assumes, as it were, a partially fluid condition, and begins very suddenly to yield permanently to the slightest force of extension, torsion, or flexure. Besides this sudden permanent yielding there are other remarkable changes which occur at the same temperature when the iron is under stress or strain,‡ which have impressed the writer with the belief that there are *two* critical temperatures in iron at which the molecular architecture is suddenly changed, one at the point when the metal begins to lose its magnetic properties, the other at a much higher temperature (somewhere about 1000° C.)

The relative susceptibilities of iron and nickel vary so much with the magnetising force that it is difficult to form any exact estimate of the relative effects of the two metals when used for thermo-magnetic motors; but it would seem to follow from the experiments of M. Ledeboer and those of the writer that the decrease in the number of lines of force per centimetre for for increase of 1° C. rise of temperature would not be very different provided the metals were used at those temperatures at which it would be most advantageous to use them. On the other hand, however, since the advantageous mean temperature for iron is more than twice that of nickel, the cooling would be more rapid in the same proportion, and there would be also a much greater range of temperature through which iron might be worked.§ Considered from an economical point of view, there would be no question of the superiority of nickel.

* *Wien. Ber.*, 1880, 1881, 1882.
† Vol. XX., No. 505.
‡ *Proceedings* Royal Society, Vol. XLII., p. 229.
§ In this respect the writer's results resemble those of Baur on iron.

* *Phil. Mag.*, Vol. 25, No. 15.
† The writer has reason to believe that in the specimen of unannealed wire used by him the estimate given by him may not be far from the truth.
‡ *Phil. Mag.*, Vol. XXV., No. 153.
§ Iron from 670° C. to 720° C.; nickel from 300° C. to 320° C.

THE SUBMARINE TELEGRAPHS.

The *Central News* learns that the Directors of the Submarine Telegraph Company, having abandoned all hope of obtaining a renewal of their concession from France, have entered into negotiations with the English Government for the sale of their cables and plant. The Government have agreed to purchase at a valuation seven cables belonging to the Company—viz., two between England and Belgium, four between England and France, and one between Jersey and France. The Government will buy, also at a valuation, the ship "Lady Carmichael," the company's buildings in London, Dover, Ramsgate, Beachy Head,

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and Jersey, with the leases, stores, instruments, and general plant. The Government have also accepted the principle of granting a gratuity to any of the *employés* of the company who, by reason of their age or otherwise, could not be taken into the service of the Post Office. It is further suggested that, instead of handing over the cables to the Government in January, 1889, when the concession expires, the company should continue to work them until the end of the financial year, April 1st, 1889. The directors of the Submarine Company, at the time of entering into the negotiations, made a strong protest against the decision of the Government, and it is understood that, recognising the justice of the complaint, the Government have accepted the principle of granting a bonus as compensation to the shareholders. This, however, is subject to the approval of Parliament. It has been practically decided that on the Post Office taking over the working of the submarine cables, either in January or in April, 1889, a uniform rate of twopence per word shall be charged to France, Belgium, Holland, and Germany.

REVIEWS.

L'Annee Electrique, ou expose annuel des travaux scientifiques, des inventions et des principales applications de l'electricite a l'industrie et aux arts. By PH. DELAHAYE. (Paris: Baudry et Cie.)

This useful annual, which now makes its fourth appearance, is intended to chronicle the progress of the practical applications of electrical science from year to year. The contents are subdivided into twelve chapters, each dealing with a separate branch of the subject. The descriptions of apparatus are well and clearly written; but since the plan of the book does not admit of illustrations or diagrams, the reader will not unfrequently wish to proceed to some more detailed account than is here provided. For this reason we think that M. Delahaye would do well in future issues to give as many references as possible to the technical journals or other publications in which fuller information on any particular subject may be obtained. Since the publication is chiefly of value as a work of reference, we may suggest that it would be as well to facilitate consultation by adding an alphabetical index; at present there is only a table of contents, which, though useful in its way, does not supply the place of an index. Attention to the points which we have named would greatly increase its value, but even as it is the book is one which every electrician who desires to keep abreast of the age would do well to place upon his shelves.

Taschenbuch fur Monteuse elektrischer Beleuchtungsanlagen. (Pocketbook for Electric-Lighting Installations.) By S. VON GAISBERG. (R. Oldenbourg, Munich and Leipsic.)

This is a new and enlarged edition of a little work which originally appeared in 1885. It is intended, as explained in the preface, for the use of foremen in charge of electric-lighting installations, and also for persons having installations carried out in their houses or works, and who being without any technical knowledge of electricity desire to know something of the general principles on which the due efficiency of the installation depends.

The first chapter is devoted to the explanation of electrical terms and the use of simple electrical measuring instruments. The author then goes on to describe briefly the principles of the construction of the different types of dynamos, arc and incandescent lamps, practical measuring instruments, the arrangement of the leads, the management of accumulators, and the electrical transmission of energy. A chapter is also given to the use of dynamos for electroplating. There are many useful hints for carrying out simple repairs and avoiding breakdowns. The different methods of arranging systems of lamps are also very clearly and concisely explained. The author is an engineer himself, and writes in a thoroughly practical style, and readers of considerably higher attainments than those to whom the book is primarily addressed will find many useful hints in its pages. We should certainly like to see something of the same kind, and equally well done, published in English. It would certainly be useful, and we have little doubt that it would have an extensive sale.

Turning Lathes. A Manual for Technical Schools and Apprentices. Edited by JAMES LUKIN, B.A. (E. and F. N. Spon, London.)

The first question that occurred to us on looking at the title-page of this book was, why should the writer describe himself as "editor" of the manual? The reason soon became evident on turning over the pages, as the work is virtually a trade catalogue of a certain firm of tool manufacturers, and the letter-press seems to be written as much to advertise their wares as to instruct the learner. We must, however, congratulate the writer on having succeeded, in spite of the restrictions imposed upon him by the design of the book, in producing a useful, readable and thoroughly practical little manual for the instruction of aspirants to the turner's art. The book is well arranged, and gives a considerable amount of information in a very compact and inexpensive form. The last chapter, which is devoted to the description of a milling machine made by the firm alluded to, appears to us out of place in an elementary manual of this kind, and would hardly, we should think, have been included if the writer had been free to use his own judgment in the matter.

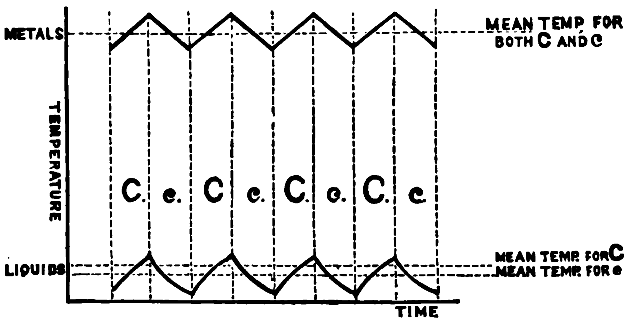
ON OHM'S LAW IN ELECTROLYTES.*

BY G. F. FITZGERALD, F.R.S., AND FRED. TROUTON, TRIN. COLL., DUBLIN.

The result of our experiments up to this is to ascertain that h in $[v = v_0 (1 - h c^2)]$ is certainly less than 5×10^{-6}.

This time last year it was hoped shortly to attain much greater accuracy than had been reached, but it is clearer now than then what a difficulty the "heating effect" is.

This inherent difficulty in studying Ohm's law in liquid electrolytes, as compared with metallic conductors, may best be understood by considering the increased difficulty which would be introduced in the determination for metals if the wire were to be immersed in an electrically non-conducting liquid. When the wire loses heat, chiefly by radiation, as when in air, its general temperature is so much above the temperature of surroundings that its rate of cooling may be considered constant for the small changes of temperature which can occur if the alternations from the larger to the smaller current be sufficiently frequent. The temperature thus rises at a constant rate while the larger current runs, and so falls again during the time the smaller current is on, the average temperature in both cases being the same. The upper part in the diagram illustrates this.



However, with the same frequency in changing currents, the average temperature, while the larger current runs, may be made very different from the average temperature while the smaller current is on, by immersing the wire in liquid, for the general temperature of the wire can then be only slightly above the temperature of its surroundings, so that the rate of cooling can no longer be considered the same throughout. The lower part of the diagram is intended to roughly represent

* Paper read before the British Association Meeting at Manchester, September, 1887.

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this. The temperature curve is concave to the lower side while the larger current runs, but is convex as the wire falls in temperature during the period of the smaller current. The "temperature effect," if thus introduced, would have to be met by increasing the speed of the contact breaker, or otherwise smaller currents should be used, which, of course, would diminish the refinement in the determination of "*h*" correspondingly.

Now this is similar to the case of a liquid electrolyte, the smaller arm of the bridge rapidly losing heat by convection from its necessary proximity to the larger bodies of liquid at both ends. The actual rise in temperature in one experiment was ascertained, through the increased resistance, to be much less than 10deg., while in some of the determinations made with metals the wire fused during the experiment, so high a temperature was reached.

The greatest speed found necessary for the contact breaker in the determination with metal conductors, when "*h*" was ascertained to be less than 10^{-12}, was about 100 per second. The fastest of the three forks we have successively employed is about 160 per second, but a much faster fork has been prepared, though as yet it has not been got to work satisfactorily.

The diameter of the smaller arm has been reduced considerably since last year. One hole of ·0027 centimetre was bored with a specially prepared needle in extremely thin mica. So that not much more can be done in this direction. The density of the greatest current which could be used through this without "heating effect" was about ten amperes per square centimetre.

DISCUSSION.

Sir WM. THOMSON: I am sure we have all been struck with the main result brought out that when allowance is made for a change of temperature, which he (Prof FitzGerald) has so interestingly explained, the accuracy of Ohm's law is verified by the experiments he has described to the extent of $\frac{1}{2000}$ per cent—a most important result, as you will all see.

Prof. MALLET: I have always been profoundly impressed by the views put forward by Profs. Williamson, Albert and Clausius, and the difficulty suggested by Prof. FitzGerald just now offers an admirable illustration of the great advantage we derive from Sections A and B meeting together. In the suggestion that has been made as to the improbability of Prof. Williamson's view—namely, that the hydrogen atoms would some of them be certain to escape from the surface of the liquid—it appears to me that the distinction which we chemists are called upon to insist—the distinction between the atom and the molecule—has been overlooked. We know nothing at present of hydrogen in the form of single atoms. In order to form a molecule they must escape. The tendency to unite with chlorine atoms appears to be stronger than that of the hydrogen with other hydrogen atoms, and consequently we see a reason why the hydrogen atoms should remain in a state of perfectly immobile equilibrium.

Prof. FITZGERALD: I have already stated that there are hydrogen atoms in the liquid, and I should expect that some of them should unite in the course of one hundred years, and thereby escape from the liquid. The great beauty of the arrangement is that the hydrogen-chlorine will not recombine.

Prof. O. LODGE: The dissociated hydrogen atoms in a liquid are similarly charged, and until they have given up those charges they cannot combine with each other and escape. At the electrodes they do part with those charges, and they then can come out of the liquid, but until they have done so they must remain isolated. At the same time the Clausius hypothesis does not necessitate the idea of atoms moving about freely. All that is necessary is to assume frequent interchange of atoms among the molecules. Unless you accept such interchanges as going on I do not see how chemists are to explain double decomposition and other things. All that is wanted is that each molecule shall not always consist of the same individual atoms, but that interchanges shall always be going on.

ON THE HEATING EFFECTS OF ELECTRIC CURRENTS.*

BY WILLIAM HENRY PREECE, F.R.S.

On March 19, 1884, I submitted to the Royal Society a paper on the heating effects of electric currents,† showing the strength of current necessary to fuse the fine platinum wire employed for protecting submarine cables from the ill effects of atmospheric electricity. The paper proved that the law that regulates the production of heat is one which can be expressed by the formula $C = ad^{3/2}$, "a" being a constant dependent on the metal used, and "d" the diameter of the wire. The current observed was that which heated the wire up to the point of self-luminosity (525deg. C.).

Since "cut-outs" of the same character as the cable lightning protector have become an essential feature of all electric lighting installations, to act as safety fuses when from accident or design an excess of current is allowed to pass through the conductor, it became most desirable to determine the current that would fuse wires of different diameters, and of different materials, so as to determine the coefficient a for all metals. The best material to use and the proper dimensions of the fusible wire to be employed for the protection of the electric light conductors would thus be easily deduced.

My source of electricity was a large secondary battery of 52 cells. I could regulate the current flowing at will by a rheostat of thick iron wire, and by varying the number of cells. The current strength was calculated by measuring the potential difference at the ends of a thick flat platinoid bar, whose resistance was 0·1822ω, inserted in the circuit, and so large that it would not perceptibly warm up nor have its resistance appreciably increased with any current used. The sizes of wire experimented upon were limited by the current. It is not safe to draw upon secondary cells for more than 10 amperes per negative plate of the dimensions at present followed. The packed plates disintegrate and become damaged with too great an output of current. Hence all my experiments were made with currents well within the range of the battery. I obtained samples of wire of various metals and of various diameters from 0·004in. up to 0·040in. It is convenient to take these measurements in thousandths of an inch (*mils*), for all our manufacturers and electric light engineers in the United States and the United Kingdom work to this gauge. The conversion of the values thus obtained into the metrical and more scientific system is very simple. The wire to be experimented upon was clamped between two small brass binding screws fixed upon a dry wooden stand.

I pointed out in my previous paper how the cooling effects of the terminals or binding screws might vitiate the results, and how necessary it was to experiment on wires of sufficient length to prevent any error occuring from this cause. I used lengths of 6 inches to determine the constants for wires free from the cooling effect, but lengths of 1¼ inch with massive terminals to determine the constants for wires used in practice as "cut-outs."

The cooling effect of the terminals very seriously affects the efficiency of the cut-outs used in actual practice, and the larger the fusing wire and the terminals the more serious is the error introduced. On the other hand, the greater the lengths of wire used as a fuse the greater the resistance inserted, and the efficiency of the system itself may be reduced. Cut-outs, therefore, should be employed sparingly and with judgment, and the fusing wire should not be so short as to impair the fusing point.

In the following tables I have tabulated the results of the numerous experiments made.

When we consider the irregularities in drawing these fine wires to true cylinders, the difficulty in determining the current at the exact moment of fusion, and the variation in the specific resistance of the metals, I think the results must be considered very satisfactory in support of the law.

Three points of observation were taken:—

1. The melting point of a small flake of shellac placed on the wire, which may be taken at 77deg. C.

2. The point of self-luminosity, 525deg. C. This was only determined roughly in air without the dark chamber I employed previously.

3. The fusing current.

SERIES I. "CUT-OUTS."

COPPER.

Diameter of wire.			Current in amperes.			Fusing current calculated from the formula $ad^{3/2}$. Amperes.	Constant "a" when d expressed in inches.
In inches.	In centimetres.	Standard wire gauge No.	Flake of shellac melted.	Wire red hot. Visible in air.	Wire fused.		
0·004	0·010	42	2·41	3·057	3·299	3·48	12033
0·005	0·013	39	2·896	4·184	4·586	4·87	12964
0·007	0·018	37	5·631	7·000	7·724	8·07	13183
0·010	0·025	33	9·976	14·160	15·44	14·23	15433
0·012	0·030	30	11·22	16·29	19·35	18·71	14748
0·014	0·036	28	13·68	19·30	21·84	22·86	13162
0·018	0·046	26	21·71	31·43	36·40	34·37	15066
0·020	0·051	25	24·03	35·61	39·37	39·05	13699
0 026	0·066	22	30·69	44·59	54·43	57·88	12978
						Mean =	13807

PLATINUM.

Diameter of wire.			Current in amperes.			Fusing current calculated from the formula $ad^{3/2}$. Amperes.	Constant "a" when d expressed in inches.
In inches.	In centimetres.	Standard wire gauge No.	Shellac flake melted.	Wire red hot. Visible in air.	Wire fused.		
0 010	0·025	33	2·365	3·915	6·281	6·006	6278·8
0·012	0·030	30	3·060	5·424	8·076	7·90	6141·3
0 014	0·036	28	3·916	6·688	9·625	9·95	5808·4
0·018	0 046	26	4·936	8·320	13·378	14·50	5537·1
0·020	0·051	25	5·926	11·430	17·780	17·00	6282·3
0·026	0·066	22	8·808	16·316	25·778	25·20	6145·8
0·030	0·076	21	9·618	20·32	30·47	31·20	5863·6
						Mean =	6008·2

NOTE.—The ratio of perceptible warmth : red heat : fusing point is (roughly) as 1 : 2 : 3 in platinum.

* Paper read before the Royal Society, Dec. 22nd, 1887.

† Roy. Soc. *Proc.*, 1884, No. 231.

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ALUMINIUM.

Diameter of wire.			Current in amperes.			Fusing current calculated from the formula $ad^{3/2}$. Amperes	Constant "a" when d expressed in inches.
In inches.	In centimetres.	Standard wire gauge No.	Flake of shellac melted.	Wire red hot. Visible in air.	Wire fused.		
0·024	0·010	42	1·427	(a) 2·243 (b) 1·876	2·536	2·536	9023·3
0·005	0·013	39	1·851	2·614	4·023	3·549	11372·0
0·007	0·018	37	3·138	3·861	5·712	5·874	9782·6
0·010	0 025	33	4·465	5·632	10·138	10·024	10132·0
0·012	0·030	30	6·115	8·610	13 840	13·178	10523·0
0·014	0·036	28	7·722	(a) 13·200 (b) 11·176	16·412	16·606	9902·4
0·018	0 046	26	8 810	(a) 18 823 (b) 14·602	22·688	24·206	9389·4
0·020	0·051	25	13·032	(a) 22·445 (b) 17·380	28·236	28·360	9977·3
0 026	0·066	22	20·122	(a) 35·400 (b) 33·783	44·256	42·040	10551·0
0 030	0·076	21		(a) 44·240 (b) 33·799	49·88	52·100	9597·2
						Mean =	10025·0

NOTE.—The wire becomes red, and then immediately much brighter (a dull white), owing probably to oxidation. To reproduce faint redness without breaking the circuit, the current can be considerably reduced. "a" is the current which caused the first visible rays of light, and so quickly changed the wire to a brighter state of incandescence, while "b" is the reduced current which reproduced the first redness. If the experiment be repeated the same effects are obtained, although the molecular structure of the wire seems to be much changed by the first heating. After fusing the wire a white powder, alumina, is found, and sometimes a white opaque bead. A wire 18 mils diameter and 10 inches long was raised to faint red with 11·22 amperes; it glowed (dull white) on one side of loop with 11·58 amperes, and when the heat had apparently spread over the whole length uniformly redness reappeared, and the current was found to be again 11·22 amperes. The wire was next raised to a moderately white incandescent state with 15·93 amperes, and with this current broke in two minutes.

GERMAN SILVER.

Diameter of wire.			Current in amperes.			Fusing current calculated from the formula $ad^{3/2}$. Amperes.	Constant "a" when d expressed in inches.
In inches.	In centimetres.	Standard wire gauge No.	Shellac flake melted.	Wire red hot. Visible in air.	Wire fused.		
0·005	0·013	39	0·910	1·530	2·150	2·062	6078·4
0·007	0·018	37	1·406	2·150	2·812	3 415	4799·3
0·009	0·023	34	1·905	3·492	5·000	4·978	5860·7
0·012	0·030	30	2·977	5·460	7·693	7·666	5849·8
0·014	0·036	28	3·639	6·619	9·926	9·660	5989·3
0·018	0·046	26	4·757	8·894	13·235	13·560	5478·1
0·020	0·051	25	5·790	11·167	15·717	15·880	5550·5
0·026	0·066	22	9·846	15·342	23·740	23·550	5060·0
0·030	0·076	21	15·055	23·740	30·690	30·300	5901·1
						Mean =	5618·6

PLATINOID.

Diameter of wire.			Current in amperes.			Fusing current calculated from the formula $ad^{3/2}$. Amperes.	Constant "a" when d expressed in inches.
In inches.	In centimetres.	Standard wire gauge No.	Shellac flake melted.	Wire red hot. Visible in air.	Wire fused.		
0·007	0 018	37	1·609	2·092	3·218	3·223	5491·8
0·010	0·025	33	2·414	3·379	5·551	5·503	5195·1
0·012	0·030	30	2·655	4·666	6·998	6·820	5325 1
0·014	0·036	28	3·540	5·108	8·368	8·590	5045 9
0·018	0·046	26	4·623	8·042	12·230	12·530	5062·5
0·020	0·051	25	6·636	9·604	14·480	14·680	5116·6
0·027	0·069	22	9·253	13·275	23·332	23·020	5256·2
0·035	0·089	20	11·263	18·502	32·986	33·200	5035·3
						Mean =	5191·1

IRON.

Diameter of Wire.			Current in Amperes.			Fusing current calculated from the formula $ad^{3/2}$. Amperes.	Constant "a" when d expressed in inches.
In inches.	In centimetres.	Standard wire gauge No.	Shellac flake melted.	Wire red hot. Visible in air.	Wire fused.		
0·007	0·018	37	1·101	1·713	1·998	1·930	3410·3
0·010	0·025	33	2 121	2·896	3·466	3·435	3460·7
0·012	0·030	30	2·406	3·425	3·996	4·320	3038·8
0·014	0·036	28	3·467	4·364	5·506	5·450	3326·5
0·018	0 046	26	3·915	6·200	7·750	7·950	3208·4
0·020	0·051	25	5·028	6·758	9·012	9·310	3180·9
0·026	0·066	22	6·362	11·500	13·212	13·800	3148·4
0·030	0 076	21	8·483	14·843	17·292	17·100	3326·1
0·036	0 091	20	13·702	22·510	24·145	22·500	3533·2
						Mean =	3292·6

I was anxious to see if the shellac flake had any influence on the fusing current:—

(a) Shows the effect with shellac.
(b) Without shellac.

TIN.

Diameter of wire.			Current in amperes.			Fusing current calculated from the formula $ad^{3/2}$. Amperes.	Constant "a" when d expressed in inches.
In inches.	In centimetres.	Standard wire gauge No.	Shellac flake melted.	Wire red hot. Visible in air.	Wire fused.		
0 010	0·025	33	1·931	2·413	2·736	2·760	2730·7
0·014	0·036	28	3·181	(b) 4·282	(a) 3·630 5·058	4·570	3051·5
0·018	0·046	26	4·078	(b) 5·384	(a) 4·976 6·117	6·670	2884·8
0·020	0 051	25	4·485	(b) 6·812	(a) 6·281 7·667	7·810	2709·2
0·026	0·066	22	6 933	(b) 11·100	(a) 10·443 12·154	11·600	2897·5
0·030	0·076	21	9·300	(b) 13·703	(a) 12·725 13·950	14·350	2683·3
0·033	0·084	21	11·380	(b) 14·930	(a) 14·192 15·414	16·500	2570·1
0·036	0·091	20	11·745	(b) 17·620	(a) 15·908 17·860	18·800	2575·2
						Mean =	2762·8

Hence it appears that shellac acts as a flux and prevents oxidation. Thus tin fuses at a temperature less than that of luminosity.

TIN-LEAD ALLOY.

Diameter of wire.			Current in amperes.			Fusing current calculated from the formula $ad^{3/2}$. Amperes.	Constant "a" when d expressed in inches.
In inches.	In centimetres.	Standard wire gauge No.	Shellac flake melted.	Wire red hot. Visible in air	Wire fused.		
0·010	0·025	33	.. ..	* 2·494	2·132 2·735	2·491	2731·7
0·012	0·030	30	2·333	* 2·855	2·373 3·097	3·274	2354·7
0·014	0·036	28	.. ..	* 3·942	3·298 4·586	4·127	2774·2
0·020	0·051	25	4·586 ..	* 5·792	5 309 6·838	7·046	2420·1
0·026	0·066	22	7·566 ..	* 9·331	8·206 9 978	10·220	2358·5
0·030	0·076	21	11,102 ..	* 12·070	11·102 12·070†	12·670	2321·5
0·033	0·084	21	11,102 ..	* 14·000	12·550 14·000†	14·620	2333·9
0 036	0·091	20	13,516 ..	* 14·962	14·240 14·962†	16·660	2189·7
						Mean =	2438 9

* With shellac. † Fused immediately after faint redness was visible.

LEAD.

Diameter of wire.			Current in amperes.			Fusing current calculated from the formula $ad^{3/2}$. Amperes.	Constant "a" when d expressed in inches.
In inches.	In centimetres.	Standard wire gauge No.	Shellac flake melted with.	Wire red hot. Visible in air.	Wire fused.		
0·010	0·025	33	1·666 ..	* 1·984	1·984 2 431	1·990	2339·5
0·012	0·030	30	1·825 ..	* 2·461	2·659 2·777	2·616	2111·6
0-014	0·036	28	3 095 ..	* 3·016	3·095 3·821	3·296	2305·3
0·018	0·046	26	3·016 ..	* 3·389	4·023 4·383	4·640	1811·3
0·020	0·051	25	3·810 ..	* 4·827	4·907 4·927	5·430	1712 3
0·026	0·066	22	5·471 ..	* no redness	7·000 7·000	8·344	1668·5
0·030	0·076	21	6·838 ..	* no redness	8·366 8·850	8·980	1702·1
0·033	0·084	21	6·526	..	10·93	11·520	1828·2
0·036	0·091	20	7·831	..	12·40	13·120	1814·4
						Mean =	1921·5

* Lead wire fuses without previously emitting light when a small shellac flake touches the wire.

(To be continued.)

Electrical Meteorology.—Advices from America state that four experimental weather stations have been established with the view of ascertaining, if possible, the laws governing atmospheric electricity and comparing the laws with the variations of the barometer. The stations have been distributed as follows:—One at Washington, the second at the Rose Polytechnic School, Terre Haute, Indiana, a third at Boston Institute of Technology, and the fourth at Cornell University, Ithaca, New York. It is thought that observations of atmospheric electricity will afford much more reliable data for predicting storms than those in present use. The potential, it is said, fluctuates before the storm in a manner exactly analogous to the barometer. At the Cornell station variations were recently noticed two days before the storm occurred.

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NOTES FROM SCANDINAVIA.

(FROM OUR STOCKHOLM CORRESPONDENT.)

An electric installation of considerable interest will soon be effected at Porsgrund, Norway, the corporation of that town having just purchased the Porssiäs Works with its water power, with the intention of using the latter for electric light and for transmission of the power, by electricity, to various industrial establishments in the town. The waterfalls and the works belonged to a bankrupt estate, and there had been several auctions before the corporation thought of acquiring the property. The price was only about 120,000kr., and there can be no doubt that the waterfall will afford a decidedly cheaper power than could be obtained by coals. A mill is attached to the property, the rental of which will probably be enough to pay interest, &c., so that the power for electric purposes will hardly cost anything. It is calculated at 1,619,000 hours. The waterfall, with lowest water, has a capacity of 300 horse-power. For the electric light streets, shops, manufactories, and private residences are reckoned to require 150 horse-power (for 1,200 lamps) and the Porssiäs Mill only requires 60 horse-power. The distance between the waterfall and the town is only 800 metres, so there will be no difficulty about the transmission.

The charge for inland telegrams in Norway has from the beginning of the present year been reduced to 50 ore (6½d.) for ten words, and this reduction has already brought about a very considerable increase in the number of messages sent.

As a proof of the general use into which the telephone has come in Sweden, I may mention that the Skåne telephone system, which comprises several smaller towns, had 1,306 subscribers at the beginning of the present year. Malmö had 560 subscribers, Helsingborg 136, Lund 125, &c. There are altogether 21 central stations.

In Sweden the Government has proposed a yearly tax of 10kr. on each telephone which has connection with a central telephone station. The reason assigned by the Chancellor of the Exchequer is the serious loss caused to the State telegraphs by the ever-increasing number of private telephones.

A central electric station is under contemplation in the town of Sundsoall, Sweden; it is intended for 1,000 incandescent lamps, although it may be started with a considerably smaller number.

The Swedish Government has during the year 1887 erected 386 new telephone stations.

The first step towards lighting streets in Malmö, Sweden, by electricity has just been taken, two arc lamps of 500 candle-power each having been placed in the vicinity and at the expense of the Hotel Kramer.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Feb. 4th*, 1888.

New York City is all agog with big schemes for improved rapid transit. As many of your readers are probably aware, New York City is an island closely resembling a forked tongue. The population has, until the last few years, been concentrated at the tip of the tongue, where it runs out seaward between the waters of the East River and the Hudson River. For a long time, for lack of convenience of travel and because of the high rates, the overflow of population found its way generally into Brooklyn and the countless scattering villages of New Jersey. A few years ago the rapid transit facilities of the island were increased by the extension of the elevated railroad system from one end of the island to the other and into the adjoining country, so that no change of cars was necessary, even in a journey of from 8 to 10 miles; but now again, owing to the rapid growth of the city, accommodation is once more seriously inadequate, and various grandiose schemes are daily brought to notice for meeting the necessities of the situation and reaping the reward. My reason for mentioning these facts is that Mayor Hewitt has himself now taken the matter in hand, and has, through the medium of a message to the Board of Aldermen, submitted to the public a comprehensive system of rapid transit, such as is likely to meet both the present and future needs of the city. I need not enter into the details of the scheme, as they could not be understood without a map, and even then would probably lack clearness, but I want to emphasise the fact that in this really remarkable message electricity plays a most important part. I am not aware that it has ever before been so prominent in an official document of the kind. In several places Mr. Hewitt proposes that the cars to be employed shall be operated by storage batteries or by electric power in any shape that may be deemed satisfactory. In one part, dealing with the question of tunnels, he alludes to the rapid improvement of the electric motor rendering it valuable for such service, and says: "I have no doubt myself that the steam engine will pass out of use in cities in a very few years." An utterance like this from such a man as Mr. Hewitt, who is not only statesmanlike in his views and training but well versed in engineering matters, is of the highest significance. Mr. Hewitt also adds: "Between open cuts and tunnels there will only be a change from daylight to electric light, which happily is now so perfected that what would ten years since have been an insuperable objection to the use of tunnels is altogether removed." It is perhaps worthy of note that over a portion of the route to which this notable message refers from City Hall to the Grand Central depot, a Julien car is now in regular operation, and that by a contract with Mr. Vanderbilt it is to be supplemented by ten more as soon as they can be built.

There has been of late in this country quite a pronounced movement looking to the general introduction of anti or non-magnetic watches. On several of the western railroads orders have been put in force compelling each conductor and locomotive engineer to carry an accurate time piece, and to submit it for inspection regularly; and the big Erie Railway Company has now taken the same action. There has been quite a run on shield devices, and a large sale has also been enjoyed by a non-magnetic watch of Swiss manufacture. The well-known Waltham Watch Company have now given their attention to the subject, and have just put on the market the first non-magnetic watch made in this country. They state as their reason for doing this that so many watches were brought to them to be demagnetised that they thought it well to provide prevention rather than cure, and they say that the balance, hair spring, and escapement are made of a non-magnetic composition, arrived at after a long series of experiments. It is a peculiar fact that the cheap Waterbury watch, whose chief use here has been to supplement the charms of shoddy clothing and swell the subscription list of cheap newspapers, has been about as successful a "non magnetic" as any yet introduced.

There is no small amount of grumbling in our large cities as to the time consumed in the delivery of local messages. Where district messengers are used delay can be accounted for, but it has been difficult to see why a telegram sent between two points only a few miles apart should require pretty well an hour for its delivery. It is here that the telephone proves itself so formidable a competitor, for even at its worst, it will put a message through in about five minutes. How to improve this local delivery might well occupy the attention of inventors and managers not only here, but in England, where, I am told, the same trouble is experienced. Perhaps the electro-pneumatic despatch system may help us out. The discussion here over the propriety of Government telegraphs has brought out some interesting information as to the methods in vogue of sending news before the telegraph became practicable. Thus it appears that at the opening of the Erie Canal in 1825 the news was communicated from Albany to New York and back again in fifty-eight minutes. This is quicker than a telegraph message could be sent and answered under ordinary telegraphic conditions to-day, and hence we have some sapient newspaper comments. The fact is lost sight of, however, that no message was actually conveyed, but that a signal was agreed upon, and that it was nothing more or less than the firing of a cannon. The guns were placed within hearing distance of each other all

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the way between the two cities, and as the preconcerted signal had its meaning for everybody, there was not much likelihood of "bulling" the message. If any of my newspaper friends want to go back to that ancient system they can, but I hope they will not expect me to live near the line when it is set up.

I mentioned not long ago a revival of schemes for utilising Niagara. One of these has now been proposed by the Niagara Falls Hydraulic Motor and Power Company of this city, which has as its secretary Mr. George S. Bowen, with whom the idea of the National Electric Light Association originated. The plan of the company is a little startling. It is proposed that shore abutments of granite shall be erected on each side of the Niagara River just above the Falls. Between these abutments will stretch a steel cable 10in. in diameter. Dependent from the cable, and swinging freely at the very lip of the Fall, will be large float boats made of steel, and loaded with ballast. They will be moored nose up stream, and at the stern will be large wheels connected together by a universal coupling shaft, so as to allow the current or the ice to move the boats without interfering with the revolution of the wheels. This shaft is to be connected with an immense power house on the American shore, in which are to be placed a large number of dynamos, grinding out current for Buffalo, Rochester, or any other city within presumably convenient distance. This is a very pretty scheme, and all that is necessary for its successful execution is that Jules Verne should be invited to act as engineer of the works. The position of the men employed on these pontoons, rocked on the bosom of the deep and shrouded in perpetual mist, will be a peculiarly interesting one. It is probable that when Sir William Thomson proposed the utilisation of Niagara for distributing electricity he was not aware of the fertility of invention that would be brought to bear on the task.

The Government telegraph discussion drags along, and there is as yet no intimation that this Session of Congress will witness any decisive action on the subject. A Bill has now been introduced into the United States Senate to subject telegraphy to the jurisdiction of the Inter-State Commerce Commission, in the same way as the railroads now are. It will be the business of the commission to prevent any objectionable agreements or combinations; to interfere when any unfair preference or advantage is given to any person, and to remove the grievances of injured parties. The Bill declares it unlawful for any telegraph company, directly or indirectly, to make discriminating rebates, drawbacks, or the like.

The New York Electric Club opened its house in East Twenty-second-street this week. There was a large attendance, and Prof. H. A. Rowland read an interesting address. The house has a complete electrical equipment, and contains a number of electrical novelties and toys. The building does not belong to the club, but is rented, and the money for furnishing, decorations, &c., has been raised by bonds. The membership consists chiefly of business men, and comprises some of the most jovial spirits in town. In catering to the social element, the club has a well-defined mission, which it now bids fair to discharge. Many experiments have already been made to demonstrate the conversion of electrical energy into mechanical energy, and this is now usually demonstrated by the conversion of magneto-electric into electro-magnetic action, or the re-conversion of current into power by means of the motor. In a lecture before the Cornell University Prof. Nichols demonstrates in a very brilliant experiment the reversibility of the static machine into a motor. He accomplishes this by the simple method of generating a continuous static charge by one machine as a generator, and leading the charge to a second one which starts off at once and runs as a motor. It would be interesting to know what the efficiency of this combination is, and what the loss through "leakage" is.

A writer in a recent article, just printed here by one of the electrical papers, in calling attention to the old scheme of employing windmills for the purpose of driving dynamos and charging storage batteries, claims that if the true economy and efficiency of the windmills, as constructed to-day, were more generally known, we should see a large number of these motors used for the purpose mentioned. He shows that the modern windmill is constructed to keep constant speed with varying velocity of wind, and that at least in this country there is sufficient wind—eight hours out of the twenty-four all the year round—to keep the windmills going. There is more in this, I think, than would at first sight appear, and with the improvements that are constantly being made in storage batteries, it does not seem unlikely that we shall in the near future see the utilisation of a power now much neglected. Why could not Sir David Salomons look into the subject and make some more of his practical tests ?

CORRESPONDENCE.

THE COEFFICIENT OF SELF-INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If your correspondent "G. B." will refer to Cumming's "Electricity," p. 207, 1st edition, he will see that the author there defines the coefficient of self-induction of a circuit to be numerically equal to *half the number* of lines of force embraced by the circuit when removed from all other circuits and carrying unit current. Also, if there are two circuits carrying currents i_1 and i_2, and having coefficients of self and mutual induction respectively L, N, and M, he gives as the value of the total electro-magnetic energy

$$L i_1^2 + M i_1 i_2 + N i_2^2.$$

It is better to define the coefficient of self-induction, as does Maxwell, as numerically equal to the *total number* of lines of force embraced by the circuit when removed from other circuits and carrying unit current, and this definition renders the expression for the total energy in the case of the two circuits,

$$\tfrac{1}{2} L i_1^2 + M i_1 i_2 + \tfrac{1}{2} N i_2^2,$$

which is mathematically homogeneous. The matter, in one word, is this: Cumming takes as a value for the unit of self-induction of a non-magnetic circuit a quantity which is twice as great as that which I, following Maxwell, have done; hence our L's are not the same. Further discussion of this point will be found in notes to follow.—Yours, &c.,

J. A. FLEMING.

BATTERY CARBONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your correspondent "Carbo," I may say that I am aware there is a wide-spread (though, in my opinion, erroneous) idea that no compressed carbon can be made to equal cut or retort carbons. Now, the essential conditions of good battery carbons are the following:—

(1) That they should not disintegrate.
(2) That they should be dense.
(3) That they should be uniform and of high conductivity.
(4) That they should contain little or no mineral impurities.

From experiments made by ourselves and our customers, extending over a period of more than three years, we have ascertained beyond doubt that the compressed plates manufactured by this company are *less* liable to disintegration than cut plates, and are of a higher conductivity than these. They are also more dense and uniform, and contain much less mineral matter.

We are so convinced of their superiority in all these respects that we should be quite prepared to run them against any cut plates.—Yours, &c., HENRY LIEPMANN.

Millwall, E., 15th Feb., 1888.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In answer to your correspondent "Carbo's" inquiry in your last week's issue I have had considerable experience

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with carbon plates, both for battery purposes and for use as insoluble anodes. In decomposition cells my experience has been decidedly in favour of the retort carbon in strong acid solutions. I have some that were sawn from the blocks that have been in use constantly for four years and are quite as good now as at first. The compressed carbon I find does disintegrate, especially when used as an anode. If your correspondent has the convenience to grind the retort carbons and burn them, I shall be glad to tell him the method I have employed to manufacture a carbon screw, 5ft. in length and 1ft. diameter. It is a very troublesome process, requiring a number of burnings and very good moulds, but I have had a screw in use for a year that does not show signs of disruption, although a very heavy current is passing.—Yours, &c., G. J. Atkins.

1, Pembury-avenue, Tottenham, London, N.,
February 15, 1888.

ARC LIGHT CARBONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The subject of cheap carbons having been often discussed in your columns, may I be allowed to draw the attention of those interested in the subject to the excellent lighting of the Victoria Station (L. B. and S. C. Railway) on the Wood's system, and to state that the uncoppered 11 mm. carbons there used are of English make?—Yours, &c.,

Chas. F. Cathcart,
Manager Globe Electrical and Engineering Co.
7, Carteret-street, Westminster, S.W.,
February 14th, 1888.

[We regret that the etiquette of technical journalism compels us to omit the latter portion of our correspondent's communication, in which he enters into particulars as regards cost and terms of delivery, &c. We have no objection to add, however, that the price is lower than we have yet known to be quoted for really good carbons.—Ed. *E.*]

PHYSICAL SOCIETY.

ANNUAL GENERAL MEETING.

The annual general meeting of this society was held at South Kensington on Saturday, Feb. 11, Dr. J. H. Gladstone, F.R.S. (vice-president), in the chair.

The Chairman read the report of the council for the past year, and expressed regret at the losses the society had sustained by the deaths of Dr. Stewart (their late president), Prof. Kirchhoff, Mr. Coutts Trotter, and Prof. Humpidge.

The council regret that no increase of members has taken place during the past year, and hope that the advantages offered by the society may be more fully appreciated in future. Obituary notices of Dr. B. Stewart, Mr. Coutts Trotter, and Prof. Humpidge were then read. The treasurer's report shows that the financial condition of the society is very satisfactory. On the motion of Mr. Lant Carpenter, seconded by Mr. Inwards, the reports were adopted. The following gentlemen were elected members of council for the present year :—President, Prof. A. W. Reinold, F.R.S.; vice-presidents, Dr. E. Atkinson, Prof. W. E. Ayrton, F.R.S., Shelford Bidwell, F.R.S., and Prof. H. M'Leod, F.R.S.; secretaries, Mr. Walter Bailey, M.A., and Prof. J. Perry, F.R.S.; treasurer, Prof. A.W. Rücker, F.R.S.; demonstrator and librarian, Mr. C. V. Boys; other members of council, Hon. R. Abercromby, R. H. M. Bosanquet, M.A., W. H. Coffin, Conrad W. Cooke, Prof. F. Fuller, M.A., W. N. Shaw, M.A., A. Stroh, Prof S. P. Thompson, D.Sc., H. Tomlinson, B.A., and G. M. Whipple, B.Sc. On taking the chair the new President expressed his sincere thanks for the great honour the society had confered upon him. Prof. Fuller proposed a vote of thanks to the Lords of Committee of Council on Education for the use of the rooms and apparatus of the Normal School of Science, which was seconded by Mr. Shaw, and passed unanimously. A cordial vote of thanks to the council and officers of the past year, moved by Dr. Blaikley and seconded by Prof. Ramsay, was duly acknowledged by the President.

A paper was then read by Mr. T. Pelham Dale "On the Limit of Refraction in Relation to Temperature and Chemical Composition." A point of interest to electricians in this paper is the anomalous dispersion of light found to exist in selenium, in relation to the influence of light on its electrical properties.

Mr. Bosanquet then read a paper entitled

Note on the use of the Term "Resistance" in the Description of Physical Phenomena.

The author stated that his paper owed its origin to a quotation at the previous meeting of the society by Prof. S. P. Thompson of a remark of Dr. Hopkinson's, objecting to the use of the term "magnetic resistance." The author defines his use of the term "resistance" with regard to physical phenomena in general as follows:—

Any physical change may be considered as made up of two component parts, namely, a cause and an effect. When there is an opposition to the change of such a nature that it is greater the greater the measure of the cause and the less the measure of the effect, such opposition may be defined as a "resistance."

Take, for example, Ohm's law, where we have

$$R = \frac{E}{C} = \frac{\text{Cause}}{\text{Effect}}.$$

Objections have been made to the use of "magnetic resistance" on the ground that it is not of the same dimensions as electrical resistance, and that it varies with different conditions. The same objections, however, may be raised to the use of the term magnetic potential as the analogue of electrical potential, or of magneto-motive force as the analogue of electromotive force. The objection in either case implies that an analogy cannot exist without identity, and therefore falls to the ground.

As another general illustration of his use of the term resistance, the author takes the resistance to compression of a substance, where we have—

$$R = \frac{\text{Pressure}}{\text{Resulting Compression}} = \frac{\text{Cause}}{\text{Effect}},$$

and in this case the resistance is a function of the compression produced just as the magnetic resistance is a function of the magnetic induction. Where the resistance varies from point to point of a curve the author defines the resistance at a point of the curve as the quotient of the small change in the cause by the corresponding small change in the effect, supposing the sum total of the conditions to undergo only a small change in the interval, or, in mathematical language,

$$\text{Resistance at a point} = \frac{d\cdot\text{cause}}{d\cdot\text{effect}}.$$

As an example of this he gives Lamont's formula for a magnet.

The author defends his definition of magnetic resistance as the quotient of magneto-motive force by magnetic induction (a magnetic flux per unit of area), against M. Hospitalier's criticisms that it should be the quotient of magneto-motive force by the total magnetic flux through the circuit, on the ground that his definition, by making the magnetic resistance a linear quantity, greatly simplifies its use for practical calculations.

Prof. S. P. Thompson remarked that he always liked to introduce the terms magneto-motive force and thermo-motive force, in teaching his classes, as the analogues of electromotive force, as he found it a great help in impressing on their minds that electromotive force is not a force, and must not be confounded with it. He mentioned that Rankine used the term thermal resistance for the reciprocal of conductivity, and we may write

$$\text{Thermal resistance} = \frac{\text{Thermo-motive Force}}{\text{Resulting Flux of Heat}}.$$

He stated that he usually gave Boyle's law to his students in the form

$$\frac{\text{Pressure}}{\text{Density}} = \text{Constant},$$

instead of in the form,

$$\text{Pressure} \times \text{Volume} = \text{Constant}.$$

Alluding to the characteristic curve of a series dynamo, where if amperes be taken as abscissæ and volts as ordinates, the machine being run at constant speed, the resistance at any point of the curve is given by the tangent of the slope at that point, Prof. Thompson suggested that it would be very useful, both for dynamos and electromotors, to draw characteristic curves expressing the mechanical conditions.

For example, in a dynamo we might take a constant driving moment instead of a constant speed, and in an electromotor we might take either a constant potential difference or a constant current. For a shunt-wound motor we might take the speed for abscissæ and the torque on the axle for ordinate, when we should have

$$\text{Resistance to driving} = \frac{\text{Torque}}{\text{Speed}}.$$

Prof. Ayrton agreed with Mr. Bosanquet's expression

$$\text{Resistance} = \frac{\text{Cause}}{\text{Effect}}$$

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provided this ratio were fairly constant within the limits considered, as is the case with magnetic resistance except for very small magnetising forces and near saturation, and did not agree with Dr. Hopkinson in rejecting the term because there were bends in the curve.

Similarly he would not reject the term electrical resistance if it should be found, as he expected, that for a sheet of metal with a large current passing through it, the ratio E/C for a given temperature varies with the strength of the current. He did not think, however, that the term "resistance" ought to be used if there were great variation. For example, he considered that we should never have used the term "electrical resistance of a conductor" if R had varied as C, say, or as C^2.

Prof. FOSTER mentioned that in teaching mechanics to his students he had found it convenient to define inertia as the measure of resistance to change of velocity, its value being given by

$$\text{Inertia} = \frac{\text{Force}}{\text{Accleration}}.$$

Moment of inertia he defined similarly as the measure of resistance to change of angular velocity.

PHYSICAL SOCIETY OF GLASGOW UNIVERSITY.

An ordinary meeting of this society was held on Friday night, the 10th inst., Mr. Maclean (president) in the chair. Mr. Thomas Gray, B.Sc., exhibited and described an improved apparatus for the determination of the intensity of the horizontal component of the earth's magnetic field.

In this apparatus a magnetometer, consisting of a small magnetic needle about 1 cm. in length, mounted in a light aluminium frame, carrying a small mirror suspended in a vertical glass tube fixed to a wooden base plate, is supported on a light but rigid wooden frame, which is capable of turning round a vertical axis. Two deflector magnets, mounted on suitable stands, are carried by a strip of thick glass, which turns round the same vertical axis in such a way that the deflectors are always on opposite sides and at equal distances from the magnetometer needle. The method is in principle the same as that of Gauss, and the apparatus is a more perfect form of that described by Mr. Gray in the *Phil. Mag.* for Dec., 1885, the *sine* method being adopted in this case, instead of the *tangent* method, as described in the paper just referred to.

TECHNICAL EDUCATION.

A conference on Technical Education was held on Wednesday evening, at the Victoria Music Hall, South London, Captain Sir Douglas Galton, K.C.B., in the chair.

The CHAIRMAN announced that letters expressing regret at inability to attend had been received from Prof. Foxley, Prof. Seely and several other gentlemen. Prof. Roscoe, that great promoter of technical education, wrote:—"Such conferences as these are of the greatest value for enabling an understanding to be arrived at between employers and workmen of what is really required for the furtherance of technical education. Our National Association has done and will do much in this direction throughout the country, but it is of the greatest importance that here in London the subject should be discussed, and the issues well considered and thought out."

After a lucid address on the general subject by the CHAIRMAN,

Dr. FLEMING advocated a great scheme of national secondary and technical education under the management of Government, and detailed the methods which such an organisation should adopt. He moved: "That it is desirable to deal in the present Session, by introducing a Bill, with the question of national education, and that a constituent element be the establishment of a Minister of Education presiding over a National Council of Education."

Prof. JOHN PERRY, in seconding the resolution, said he might to some extent be regarded as a little antagonistic to some of the views usually brought forward before meetings of this kind by professional speakers. True, he was a professor, and a Fellow of the Royal Society, but as a matter of fact he had been apprenticed as a workman, and worked at the bench (cheers). He had the most intense sympathy with workmen. On the whole, the workman is fairly right in many of his notions; in bringing them forward he is a little inarticulate; he says nonsense very often; he speaks rubbish; but there is a great deal of meaning underlying that rubbish, and it is the duty of those who deal with the legislation of this country to find out the grains of wheat among the mass of chaff. He perfectly agreed with what had been said by the Chairman and by Dr. Fleming as to the advantages of machinery. Of course we could not destroy machinery. Without isolating ourselves completely, and reducing England to the position in which Japan was 25 years ago, we could not destroy machinery. What we call bad trade is after all simply that our machinery is not as perfect and our methods of working are not as perfect as they ought to be, and that we had to improve them. There is more skilled labour on the whole employed now than there was twenty-five years ago or fifty years ago. For every weaver like Silas Marner of one hundred years ago weaving in the neighbourhood of a village, the weaver of the village—for every one man like that there are one hundred men now employed at over £2 a week, and perhaps a thousand women and boys. All this was quite true, and it was folly to deny the advantages of machinery. But there was one thing which did not seem yet to have come home to our legislators, and that was that machinery was creating a wonderful amount of unskilled labour in this country. Nowadays a boy at the wages of 15s. or 18s. a week by simply turning two or three handles could turn out work which not long ago would have required two weeks' labour, and not turned out the work so well. But what was the future of the boy? It was quite true that with machinery a great deal more skilled labour was employed than hitherto, but, on the other hand, there was an immense amount of unskilled labour, and that constituted the great difficulty of the problem that had to be dealt with. Machinery was gradually getting to be the master instead of the slave of men. The remedy for this was technical education. As to the suggestion that there should be technical instruction given in Board schools, he considered that it would be simply iniquitous to do so; it was only increasing the amount of unskilled labour in the country. If a boy were intended to become a practical cabinet maker, or a good fitter or pattern maker, he should not be allowed to touch a tool, especially in such a place as a school workshop, until he was at least 13 or 14 years old. As Science Master at Clifton College he introduced in 1870 the first school workshop, and it had been a great success; but the boys attending that school were not intended to be workmen, and they enjoyed the workshop because it was an agreeable variation from cricket and football and other amusements. The English technical education problem was quite different to that which had been solved elsewhere. The problem of middle class education had already been solved here. In 1880 he published a paper in *The Electrician*, detailing a scheme of technical education for the middle classes, and that scheme had since been successfully worked out at the Finsbury Technical College. The middle class technical education was merely the fringe of this question. As to evening classes meeting the difficulty, he had lectured to evening classes, and he felt that the working men who attended them were simply heroes. One of his pupils at the present time did not get home after attending the classes till midnight, and had to get up at four o'clock in the morning. Of course if that young fellow lived he would be a very successful man; but was it possible to compel the working men of this country to attend classes in that fashion? He would like to see a revival of the old apprenticeship system (he belived it survived only at Sheffield) by which the workmen themselves were allowed to take lads as apprentices. It was no use trying to accomplish technical education by means of night classes; the master should give a third of the working day to the practical teaching of his trade and of the principles underlying the trade. Already there were half-time classes for children in towns where there were mills; why should not there be third-time classes, where apprentices could devote a portion of the working day to obtaining the technical instruction which was absolutely essential? This was the system of technical education for the working classes which he advocated. There might be difficulties in the way; of course there were; but it was for the Legislature to find out the means of getting over those difficulties. It was for Parliament to compel the masters and employers to carry out some such a scheme. Until something of the kind was done, it would be found that the unskilled labour in the country would increase; it was already reaching tremendous proportions, and, unless steps were speedily taken to diminish it, the people would soon become the mere slaves of machinery, instead of reaping advantages from it.

A letter was read from Prof. Lant Carpenter, in which he complained of the present system of education in the Board schools as being altogether too "bookish." The age at which boys should be kept at day schools should be later than at present, and after leaving day schools they should be compelled to attend evening continuation schools, as was the case in almost every Continental country. Any legislation on this matter would not be satisfactory which simply dealt with the technical education of a select few. The present system of elementary education must be altered so as to make it a satisfactory preparation for technical education.

An interesting discussion followed, and finally the resolution was carried unanimously.

THE ELECTRIC LIGHT AT THE FORTHCOMING GRAND EXHIBITION AT COPENHAGEN.

Our Copenhagen correspondent writes:—

The works in connection with the Grand Scandinavian and International Exhibition, which is to be held this year at Copenhagen, are already far advanced, and the committee are determined that everything shall be ready and in its place on the opening day, May 18th. The main building, a most unique and imposing structure, has already been roofed for several months, and a number of auxiliary buildings, among which is a huge machinery hall, are approaching completion. The electric light will be used in several of the buildings—although not the principal one—and in the splendid grounds which adjoin, and have been amalgamated with the exhibition. Among the buildings which will be thus lighted are the fishery exhibition and the aquariums, the horticultural exhibition, the exhibitions of the army and the navy, the part of the machinery hall containing steam engines and dynamos, &c. The following firms will join in the

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arrangements for electric light, the first three being Scandinavian concerns :—P. Jürgensen's Electric Company (Limited), Copenhagen ; S. C. Hanberg's engineering and electrical works, Copenhagen ; and Palmerantz and Co., Stockholm. Of foreigners, there are S. Schuckert, Nürnberg, through his agent, Mr. L. Lund, Copenhagen; Siemens and Halske, Berlin, through their agents in Copenhagen, Otzen and Thorsteusen ; and finally the Allgemeine Electricitätsgesellschaft, in Berlin. English, French, and American firms appear to be conspicuous by their absence, although at least one American firm does a very fair business in Sweden.

THE NAVAL TRAINING SHIPS AT DARTMOUTH AND THE ELECTRIC LIGHT.

The Royal naval cadets' training ships at Dartmouth (H.M.S.'s "Britannia" and "Hindostan") are being fitted with the electric light (says the *Western Daily Mercury*) on the supposition that the ships will remain in their present situation for twenty years to come. The installation will consist of about 450 16 candle-power Edison and Swan glow lamps, which will be distributed throughout the two ships. The study rooms take about 60 lamps in the "Britannia" and 50 in the "Hindostan," in several instances portable table lamps being provided. The latter are for the use of cadets when engaged in drawing, &c. The cadets' mess room will be brilliantly lit with 32 lamps of very large size. Each light may be turned on or off at will by means of an independent switch fitted to the lamp. The fittings are of gun metal, and of the pattern generally in use in the Royal navy. The wiring is divided into six main circuits, viz., three pair for each vessel, while all the main cables and branch wires are of the lead covered type, and were specially manufactured for these ships. The dynamo, which is of the Siemens HB type, is designed to give an output of 32,000 watts at a terminal pressure of 82 volts, and will be coupled direct to one of Willan's G size central valve engines, run at a speed of 400 revolutions per minute. The boiler, which will be of the locomotive type, 30 horse-power, will be made entirely of steel, with wrought-iron ashpan and support. It will be constructed to work at a pressure of 120 pounds, and will be fixed on the upper deck of the "Hindostan," where a special house, with corrugated iron roof, will be erected for the electrical machinery. In the dynamo room, one of Scott's patent Admiralty switchboards will be fixed, so that the whole of the circuits can easily be controlled by the attendant. The contractor for the work (with the exception of supplying and fixing the boiler and engine-house, which has been entrusted to Messrs. Hornby and Sons, of Grantham), is Mr. Ronald A. Scott, of London, brother of Commander Percy Scott, R.N., the work being carried on under the supervision of Mr. C. N. Russell, electrician to the contracting firm. Mr. Russell has had considerable experience in this branch of electricity, having superintended the electric lighting of H.M. ships Devastation, Mersey, Severn, and Hero, and of the ships Laurence and Dalhousie. The fitting of the lamps, &c., will be completed in a few weeks, but the boiler, engine-house, &c., will not be ready until nearly Midsummer. The whole work, it is estimated, will cost about £3,000.

ELECTRIC LIGHT IN A DUNDEE CARPET FACTORY.

An important installation of the electric light was inaugurated in Dundee on Saturday last, when the new Lawside Carpet Factory of Messrs. James Paterson and Co. was formally opened. For some years the jute industry has been so depressed that Dundee manufacturers have naturally been unwilling to incur the capital outlay which an introduction of the electric light on a large scale necessitates, and only small installations have been made in cases where, from the works being run at night, electricity is distinctly cheaper than gas. So far as the lighting of an entire factory is concerned, Messrs. Paterson's is the pioneer installation of the district. The factory is entirely new, and is in every way a model one. The whole building, with the exception of stores and offices, is on one floor, covering an immense area, and lighted from the roof. All the shafting is concealed in brick-built tunnels underground, so that there is nothing to interrupt the view overhead, and a perfectly clear space is left for the forest of electric pendants which hang over the warping mills, the looms, and the other machines. The whole building is lighted by electricity. In the offices gas fittings are also used ; but in the main work rooms the only provision for gas lighting is a few Bower lamps to supply light while the people are dispersing after the engine has stopped. These are kept burning low, and are ready to be turned up at a moment's notice.

The dynamo is a compound-wound 100-volt "Manchester" machine by Mather and Platt, with a capacity of 550 16-candle lights. It is driven from the main engine—a vertical tandem Carliss, for which the makers, Messrs. Douglas and Grant, of Kirkcaldy, received a gold medal at the Edinburgh Exhibition. The dynamo room is close to the engine room, near the centre of the factory, and from the main switch-board in it five main circuits radiate to supply different sections of the building. The largest is the weaving shed circuit, in which there are 288 lamps on one switch, fed by a pair of 19—11 mains. These extend along the centre of the weaving shed, a room 260ft. long and 132ft. wide, and branches proceed to right and left over each row of looms. Another large circuit is that of the finishing department, a room 150ft. long and 90ft. wide. Another circuit supplies fifty-two lamps in the offices, and leads to a local eight-way switch-board there by which the separate office rooms are controlled. Another circuit supplies the engine room, and the fifth leads by an underground cable to a group of outbuildings devoted to hand loom weaving. The most distant lamps are 350ft. from the dynamo. Nearly all the lamps are hung from the roof by twin flexible conductors with the usual india rubber and braided silk insulation. The lamps are held in bayonet-jointed vitrite sockets with conical reflectors of white enamelled sheet iron. At the warping mills, and some other machines, and in the office, rising and falling pendants are employed ; over the looms the lamps are hung at a fixed height of 42in. above the cloth. The narrowest looms have one lamp each ; wide ones have two, and some specially wide ones have three. The mains and branches are carried at the level of the beams of the roof. They are all enclosed in wooden casings, and where the casing extends from frame to frame of the roof, as it does in the branches, it is made strong enough not only to span the gaps without sagging, but to stand having a ladder set against it, and even to carry the weight of a man. Hedges and Cockburn cut-outs are used for the mains and branches, and in the offices the rising and falling pendants are each protected by an individual cut-out in the ceiling ferule ; otherwise cut-outs are sparingly used, and only to cover considerable groups of lamps. The electric fittings of the offices are kept distinct from the gas fittings, but have been chosen to harmonise well with them. All the mains and branches have a sectional area of at least 1 square inch per 1,500 sixteen candle-power lamps. There are in all more than 420 lamps of that power, in addition to a few of 8, 32, and 50 candles. The lights were turned on on Saturday evening in the presence of 800 workpeople and visitors, and had a satisfactory run of fully five hours. The whole contract has been carried out by a local form of electricians, Messrs. Lowdon Brothers, to the specification of Prof. Ewing, F.R.S., who has acted as consulting engineer on behalf of Messrs. Paterson and Co. We understand that this pioneer installation will shortly be followed by another of similar size in the same locality.

THE GAS-LIGHT AND COKE COMPANY AND THE ELECTRIC LIGHT.

The half-yearly meetings of the more important gas companies afford the electric lighting interest a favourable opportunity "to see ourselves as others see us." Our readers will therefore probably be interested in the following extracts from the report of the proceedings of the half-yearly general meeting of the Gas-Light and Coke Company, which took place last week. In his opening remarks, Colonel W. T. Makins, M.P., the chairman of the meeting—who, by the way, is entitled "Governor" (not Chairman) of the company—spoke as follows :—

With regard to the electric light, there has been another little flutter over it in the City ; but I cannot find that much capital has been raised. There is a beautiful pamphlet that has been sent out by the House-to-House Electric Light Company ; and I think, from the way it is prepared, that it comes from Mr. Hammond. There is a great deal in it respecting gas ; and I think I have never read a series of statements as to gas more utterly without foundation than those in this little book. When, however, persons have anything to sell, they are not particular as to the terms they employ respecting the article of their rival. There is one thing about the electric light in the City. In comparing the cost of gas and electricity, they take the former at 2s. 5d. instead of 2s. 2d. per 1,000 cubic feet—at which it is now being supplied ; and 3d. represents a considerable difference in making comparisons with the electric light. They say that the cost of electricity is equal to 6s. 6d. per 1,000 cubic feet for gas ; but people who know a great deal about the matter say that 10s. would be nearer the mark if it were thoroughly gone into. However, the electric light people have their sphere, and we have ours ; and I do not think we need be afraid of anything they do or say.

Mr. JACKSON, who followed, said that in respect to street lighting the competition would he believed increase. He had been passing a few weeks in a Midland town, where an Electric Lighting Company, in order to get the introduction of their system into the shops, had supplied the light for nothing ; and their efforts had been attended with immense success—the light surpassing anything that gas could do in regard to showing up articles of refinement in the shops. He thought that such efforts were not

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to be disregarded by gas companies. The Electric Company he alluded to had laid out £35,000; and their enterprise and energy were shown in their expending this amount on an experiment. In addition to the lighting of the shops, they had put up the light in the main street at their own cost; and they determined to take no steps to obtain custom until the people of the town had satisfied themselves as to the advantages of the light.

A SHAREHOLDER inquired the name of the town which had been referred to by Mr. Jackson where the electric light was in use.

The GOVERNOR: I suppose he means Leamington.

The SHAREHOLDER: Then I have seen the electric light at Leamington many times; and it is anything but a success.

Mr. CARBUTT said that he did not think that the electric light was going to put down gas; but he thought it was well that the Directors should always keep in view the fact that the electric light was a severe competitor. He knew that the Board had taken every means in their power to make themselves acquainted with everything concerning the electric light. Mr. Aird, he believed, had had the electric light laid on in his house; so that he certainly would know what was going on. A paper had recently been read at the Institution of Mechanical Engineers, in which it had been shown that, for the lighting of big works, the arc light could compete with gas lighting. They must therefore, he thought, look to their laurels. He considered that they ought to make experiments as often as was necessary, in order to see what was doing, and what could be done with respect to improving their gas. His impression was, having seen their works, that they need not be frightened about the electric light.

Mr. C. E. JONES (Chesterfield) said that, as one who had had something to do with electricity and being conversant with gasworks all his life, he might observe that where electricity had endeavoured to compete with gas at 2s. 2d. per 1,000 cubic feet for public lighting it had been a failure beneath contempt; and as far as he could see, it was likely to remain so. The great competition that the gas interest had to face was not electricity but oil – oil that paid neither rates nor taxes; oil that was allowed to come into the country duty free; oil that was allowed to be taken from door to door, and respecting which even the machines for its consumption were allowed to come into the country without any duty whatever, whereas gas was taxed, and most iniquitously taxed.

The GOVERNOR, in the course of his reply, said that Mr. Andrews dealt with the electric light at Leamington, and Mr. Carbutt spoke about that matter also. I do not wish in any way to minimise the effect of the electric lighting on gas lighting. All I say is that it is not a direct competitor with us, any more than are wax candles or colza oil lamps. Some people will not burn gas if they can get anything else which does not produce the effects they dislike in the consumption of gas. In that case they will not take gas at any price. We have not a direct competitor in the electric light in that way. But, at the same time, the question of price must come into play; and our reduction of price must tend to throw difficulties in the way of electric lighting companies. I dealt with this book of the House-to-House Electric Lighting Company. The company own to having to charge 6s. 6d., as compared with 2s. 9d. for gas; and that is a very considerable difference between us. I also said that I do not believe in the 6s. 6d.; but there is no doubt whatever about the 2s. 9d. There is another thing which consumers are beginning to find out. Invitations are being sent out to houses similar to the one I occupy; and Mr. Ward has also been asked to be one of 50 to guarantee the consumption of electricity for so many years. It would, however, be a very one-sided guarantee. They do not guarantee to supply the electric light for three years. They are not on the same lines as gas companies. The meter spoken of in this book is exceedingly intricate, and I am not prepared to accept the statement that it is perfectly accurate. When the Board of Trade has testified to its being a perfect meter and have had time to consider it, and when the electric light companies are put under the same restrictions as the gas companies, they may fairly ask to compete with us. I notice that Lord Thurlow and Major Flood Page state that they are prepared to accept the restrictions put on gas companies. If that is the case, *cadit quæstio*. I do not suppose we should have any *locus standi* to oppose them.

THE ELECTRIC LIGHTING OF ST. JAMES'S, WESTMINSTER.

Report of the Lighting Committee of the Vestry of the Parish of St. James, Westminster, on the Draft South Metropolitan Electric Lighting Order.

Your committee have to report that they have given very careful consideration to the clauses of this draft order.

Throughout their deliberations they have endeavoured to keep in view the interests of the general body of consumers of electricity, and the rights to be maintained by the vestry on behalf of the public, such as the uninterrupted use of the streets for traffic, and at the same time to bear in mind that any undue restrictions would probably interfere with the working of the order on commercial principles, and therefore indirectly affect prejudicially the interests of the consumers. A new undertaking, such as the supply of electricity from a central station, must necessarily pass through an experimental stage, and until sufficient knowledge has been gained by actual experience of the operation of a Provisional Order under the Electric Lighting Act, it is evident that the full effect of many of the clauses of the draft order under consideration is to some extent merely speculative.

Some of the conditions which the undertakers seek to attach to a right to require a supply of electricity are so onerous as to be almost prohibitory in character. Thus by Clause 20 the undertakers propose that they shall not be compelled to supply electricity to any private consumer in a street where a main has not been laid, unless six or more owners or occupiers of property in such street enter into an agreement, binding them to pay for a period of three years such a sum as will represent twenty per cent. per annum upon the cost of laying such distributing and other mains as may be necessary. In addition to this agreement, however, the would-be consumer may be required by Clause 41, after a distributing main has been brought within twenty-five yards of his premises, to enter into a written contract to receive and pay for a supply of electricity for a period of two years, of such an amount as to be equivalent to a return of not less than twenty per cent. per annum on the outlay incurred in providing any electric line that may be necessary. Your committee are of opinion that if the Company obtain their Provisional Order and attempt to enforce such conditions as these to any large extent, the general introduction of electricity for the purpose either of light or power, will be relegated to the very distant future. Such being the case, it would appear to be an act of wisdom if the undertakers were to eliminate all such prohibitory conditions from the order, and afford all possible facilities for the introduction of the new means of lighting.

One very important point to which your committee have directed their attention is the possibility of the gas company's undertaking eventually proving less remunerative in the poorer portion of the parish, owing to the withdrawal of the larger consumers in the principal streets, to whom expense may not be so much an object as the greater cleanliness and coolness which are anticipated from the adoption of the electric light. In that case the mains would have to be charged with gas as at present, and it is evident that the area and cost of distribution would be proportionately increased as the length of unprofitable mains extended. In such a case, the price of gas would probably rise, and the increased cost would mainly fall upon the consumer in the poorer localities. It is, indeed, possible for the poorer locality to be deprived both of gas and electricity, for under the provisions of the Electric Lighting Act the Board of Trade may relieve a gas company of their obligation to supply gas in an area sufficiently supplied with the electric light, if such area has become unremunerative, while the price of electricity and the conditions attached to its supply may be a serious impediment to small householders. This contingency may be remote, nevertheless your committee think the point of such importance as to deserve the consideration of the Vestry and to engage the attention of the Board of Trade.

The order differs in one or two material particulars from the Edison Order of 1883 (since revoked), which may for all practical purposes be regarded as the model order of the Board of Trade. For instance, only one area of supply is now spoken of, instead of two as formerly, one a compulsory and one an optional area. No streets are now specified in which mains are to be laid as a matter of course, but a main is to be laid in any street in any part of the area, either on the requisition of private consumers or of the local authority (Clause 19). The committee are inclined to think that the adoption of only one area of supply and the omission of specified streets is an improvement, inasmuch as it places the whole area and every street contained in it upon an equal footing, and allows the undertakers free scope to develop the undertaking on a purely commercial basis.

Taking in numerical order those clauses which require alteration, your committee are of opinion and recommend that the Board of Trade should be requested to amend the draft order in the following respects:—

Clause 4.—The capital of the undertakers is stated at £250,000. Your committee are of opinion that this sum is utterly inadequate to carry out the obligations of the order in so large an area as is proposed, unless the undertakers have taken power in their Articles of Association to largely increase their capital, and that the attention of the Board of Trade should be directed to this subject, with a view to their taking any additional guarantee they may consider necessary when the order becomes operative. Your committee would view with great disfavour any attempt to form a company for the purpose of obtaining a concession, so to speak, for the supply of electricity in a large area of supply, with insufficient capital, with the intention of subdividing the area into districts, each to be supplied by a company floated by the original undertakers.

Clause 5.—The area of supply is an irregular oval or oblong, extending from Shaftesbury-avenue, at its junction with Broad-street, to Lower-marsh, Lambeth, in one direction, and from the eastern end of the Green Park to Bridge-street, Blackfriars, in the other. The northern part of the parish is excluded from the area of supply, and being limited in extent, and, speaking generally, of a poorer character than the Pall-mall district, it could not profitably be formed into an independent area of supply, and would therefore stand at a considerable disadvantage. Your committee therefore recommend that the order be opposed as a whole unless the undertakers consent to alter the boundary line of the proposed area of supply so as to comprise the whole extent of the parish within its limits.

Clause 9.—By the second paragraph of this clause, the undertakers would acquire large powers, apparently involving a frequent if not constant interruption of traffic, and your committee recommend that the clause be amended so as to better define and limit the powers of the undertakers in the use of their distributing boxes laid in public streets, or to restrict such use to hours when the streets are least used for traffic.

Clause 10.—By this clause, the undertakers are required to give one month's notice of their intention to carry out works involving the disturbance of the surface of a street, but no part of the month of August is to be included in calculating that period. Having regard to the fact that many local authorities do not resume their meetings until towards the end of September, your committee recommend that the clause be amended to read "no part of the months of August and September shall be included."

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Clause 11.—The undertakers seek power either to pay or secure compensation for disturbance in streets not repairable by local authorities. This proposal seems to be too ambiguous to be satisfactory, and your committee recommend that the words "secured," "securing," and "secure," be omitted from sub-sections (A) and (E), and the clause amended accordingly.

Clauses 12 and 13.—This clause as drawn prohibits interference with sewers vested in the Metropolitan Board of Works. Sewers vested in the vestry would probably be usually protected by a previous clause (10), but as that clause might not meet all cases, Clause 12 should be amended by inserting after Metropolitan Board of Works the words "or part of any sewer vested in any vestry or district board of works." Clause 13 should be amended in the same manner, and also by the insertion of the words "or to such vestry or district board of works" in line 20.

Clause 17.—It is difficult to realise the full import of the words "after the expiration of the period of two years" at the commencement of this clause. Apparently, the undertakers might occupy the field for two years without coming under any obligation to even commence the installation. Possibly the undertakers may urge that two years will not be too long to establish and equip the lighting station or stations required, but the power reserved to the Board of Trade in the latter part of the clause seems amply sufficient to meet such a case. It is doubtful, moreover, whether the undertakers could lawfully lay a main in a street until after the expiration of two years, however willing they might be to do so, if the clause remains as drawn. Your committee therefore recommend that the words "after the expiration of the period of two years" be omitted. The penalty for making default in laying mains is specified in the following clause.

Clause 18.—If the undertakers make default in laying down mains within the time prescribed by the Board of Trade under the 17th clause, the Board may, upon the application of the vestry, revoke the order in whole or in part, or may suffer the order to remain in force, subject to such conditions as they think fit to impose, and these conditions will be binding upon the undertakers. The undertakers propose that their consent should be necessary before the Board of Trade can revoke the order as to part of the area of supply, on the failure of the undertakers to lay down mains, although they assent to the Board possessing absolute power to revoke the order as a whole. Your committee are at a loss to appreciate this distinction, and therefore recommend that the words "(with the consent of the undertakers)" be omitted.

Clause 20.—In line 28, the word "five" should be altered to "three," to correspond with line 14. Three years is proposed as the period for which the undertakers may require a consumer to enter into a contract to take electricity, before they are compelled to lay a distributing main. By this clause the undertakers may require six or more persons severally to enter into an agreement to pay for a supply of electricity for a period of three years; this provision might saddle one party with the whole cost of the supply of electricity to all the persons party to the agreement. Your committee therefore recommend that the clause be amended by the addition of the following words:—"Provided that no person executing such agreement shall thereby become liable for payment of any amount beyond his proportionate share of the amount specified to be paid in such agreement, having regard to the number of persons party to such agreement, and the quantity of electricity supplied to each of such persons."

Clause 21.—Under this clause, the local authority may be required to enter into an agreement to take electricity for lighting public lamps for a period of three years. Your committee are of opinion that the 48th clause, which regulates the price of electricity supplied to public lamps, according to circumstances, including the cost of mains and wires specially laid, fully meets the case, and therefore recommend that Clause 21 be omitted.

Clause 41.—This clause restricts the supply of electricity to premises within twenty-five yards from any main already laid, and is not consistent with the 20th clause. In the opinion of your committee this clause (the 41st) should be omitted altogether, and the provision made therein for regulating the laying of service mains incorporated with the 20th clause, or if the clause is allowed to remain, the words "within the area of supply" should be substituted for "within twenty-five yards from any main of the undertakers." The clause requires further amendment in that provision which fixes 20 per cent. per annum on the cost of service lines as a minimum charge, apparently leaving the undertakers full liberty to fix any proportion they please as a maximum. The words "not less than twenty pounds per centum" should be omitted, and the words "not more than twenty pounds per centum" inserted in lieu thereof. A third amendment in this clause is also required; the undertakers seek power to take security, after they have given a supply of electricity, for the payment of all moneys which may from time to time become due in respect of such supply. Your committee think this provision might prove needlessly irksome, and recommend that the words "from time to time" in line 20 be omitted, and that the words "during the then current quarter" be inserted after the word "supply" in line 20, so as to limit the power of the undertakers to require payment in advance for the current quarter only.

Clause 43.—Gas companies are required to light public lamps if they are not more than 75 yards apart. The undertakers seek to impose a limit of 50 yards from a main in the case of public lamps. Your committee are of opinion that the undertakers should be required to supply public lamps with electricity if they are within seventy-five yards of a main, and recommend that the clause be amended accordingly.

Clause 45.—Both the Board of Trade and the vestry have hitherto regarded supply by meter as the most satisfactory method to adopt in principle. In the absence, however, of any completely satisfactory meter, it is evident that other modes of supply must be adopted, at least as a temporary measure. Perhaps it would be well to recognise supply by meter as the method to be ultimately adopted, by adding at the end of the clause some such words as these: "In the event of the undertakers adopting more than one method at the same time as the basis of charge in any portion of the area of supply, any consumer in such portion of the area of supply may elect by which method he shall be charged." And your committee recommend accordingly.

Clause 55.—By this clause the undertakers take power to let meters. Words should be added declaring that the meters and fittings are not subject to distraint. The clause relating to gas meters (10 Vic., cap. 15, sec. 14) might be adapted.

Clause 63 (B).—This portion of the clause might lead to the elimination of a poor district, and if the supply of gas should then be carried on without profit in that district, and withdrawn under the provisions of the Electric Lighting Act, some hardship might result. However, the consent of the Board of Trade is required to make this clause operative, and bearing in mind the attention the Board has hitherto paid to the representations of the local authorities on the subject of electric lighting, there is perhaps little to fear that the provision will be allowed to operate prejudicially to the poorer classes. Your committee, however, think that the attention of the Board should be specially directed to this point.

Clause 69.—The proposal to constitute the Board of Trade a court of first instance between a complainant and a Court of Summary Jurisdiction is open to objection, and your committee recommend that all words after the word "jurisdiction," in line 11, be omitted.

Your committee have not attempted to deal with any technical questions, such as are dealt with in Clauses 8 and 60, but, as on former occasions, leave these to be decided by the Board of Trade, acting upon the advice of experts.

Your committee recommend that a copy of this report (supposing the same to be adopted by the vestry) be forwarded to the Board of Trade as embodying the representations which the vestry are desirous of making on the draft order in question, and of the objections which they take thereto; that a copy be sent to Messrs. Bircham and Co., parliamentary agents for the order; and that a copy be also sent to the Metropolitan Board of Works, in reply to the enquiry of their engineer as to the nature of the objections (if any) which the vestry take to the draft order.

All which your committee beg to submit.

(Signed) WILLIAM JENKINS, Chairman.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

1,649. W. DAVIS and T. J. TURNER. London. The sectional vulcanized fibre electrical incandescent lamp cap and crown. February 3, 1888.

1,681. W. T. GOOLDEN and L. B. ATKINSON. Clapham. Improvements in electrical appliances and apparatus connected therewith. February 4, 1888.

1,707. H. A. FERGUSSON. London. Process for recovering zinc and alkali from spent liquors of Lalande voltaic batteries. February 4, 1888.

1,733. W. J. S. BARKER-STARKEY. Manchester. Improvements in the method of and apparatus for depolarising the negative elements of galvanic batteries. February 6, 1888.

1,803. F. L. RAWSON and W. WHITE. London. Improvements in switches and switch-boards for electrical purposes. February 7, 1888.

1,818. G. W. RHODES. London. Tanning by electricity, in a tanning pit or trough, the combination of motionless hides, skins, &c., with a circulating tanning liquor traversed by an electric stream. February 7, 1888.

1,835. J. T. ARMSTRONG and A. SERRAILLIER. London. Improvements in the construction of apparatus for communicating currents of electricity to persons on the introduction of specified coins or checks. February 7, 1888.

1,869. A. TACK. Blackheath. Improvements in the manufacture of carbons for electric purposes. February 8, 1888.

1,875. G. HOOKHAM, Birmingham, and R. H. HOUSMAN, Bromsgrove. Improvements in dynamo-electric machines and in electromotors. February 8, 1888.

1,876. G. HOOKHAM. Birmingham. Improvements in the armatures of dynamo-electric machines and of electro-motors. February 8, 1888.

1,891. M. BAILEY and J. WARNER. Finsbury. A flexible battery cell and method of arranging the elements therefor. February 8, 1888.

1,919. A. J. HOWES. London. An improvement in arc electric lamps. February 8, 1888.

1,926. H. C. BRAUN and A. FORD LLOYD. London. A mechanical chair or seat for the delivery of a current of electricity upon the insertion of a coin. February 8, 1888.

1,932. F. H. ROYCE. Manchester. Improved forms of electrical contacts for switches and similar fittings. February 9, 1888.

1,964. F. T. SCHMIDT. Bradford. Improvements in electrical switches suitable for incandescent lamps. February 9, 1888.

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1,968. W. Tilley. Brighton. An improved secondary battery or accumulator for the storage of electricity. February 9, 1888.

1,981. T. Parker, of the firm of E. Parker (Limited). Manchester. A new or improved electro-motor. February 9, 1888.

1,991. T. L. M. Hare and L. Boudreaux. London. The manufacture of nickel electro types. February 9, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

Note.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

February 11, 1888.

3,225. R. Dick and R. Kennedy. Glasgow. Improvements in and relating to the generation and distribution of electric energy and machines or appliances therefor. March 2, 1887.

4,032. M. Immisch. London. Improved holder for brushes of electromotors and dynamo-machines. March 17, 1887.

4,322. J. Hopkinson and E. Hopkinson. Improvements in dynamo-electric machines. March 22, 1887.

4,472. S. P. Thompson. London. Improvements in electro-deposition of cobalt. March 25, 1887.

4,978. F. T. Schmidt. Bradford. An improved holder and switch for electric lamps. April 4, 1887.

4,980. F. T. Schmidt. Bradford. Improvements in apparatus for making and breaking electrical circuits in connection with call or alarm boxes. April 4, 1887.

5,009. J. T. Armstrong. London. New and improved methods of charging and re-charging, cleaning, changing and varying the chemicals and liquids used in secondary batteries (or accumulators). April 4, 1887.

5,092. B. Egger. London. Improvements relating to switches for electrical purposes. April 5, 1887.

5,228. W. H. Bayley. Walsall. Improvements in holders for incandescent electric lamps. April 9, 1887.

5,707. E. F. H. H. Lauckert and H. W. Kingston. London. Improvements in automatic cut-outs for electric arc lamps worked in series. April 19, 1887.

6,972. J. C. Mewburn. London. Apparatus for obtaining derived currents of variable intensity from a main electric current (La Société Anonyme pour la Transmission de la Force par l'Electricité, France). May 12, 1887.

PATENTS SEALED.

February 3, 1888.

1,176. J. Harrington. Coventry. Improvements in musical instruments or chiming apparatus, the hammers of which are operated by electricity. January 25, 1887.

1,499. T. O. Callender. London. Improvements in laying and insulating underground wires intended for use as conductors of electricity. January 31, 1887.

6,584. R. B. Maddison. West Sunderland. Improved electric marine governor. May 5, 1887.

13,778. W. Walker. Liverpool. Improvements in automatic electric signalling for railways and apparatus therefor. October 11, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

563. 1887.—H. H. Leigh (Clerc). Dynamo electric machine. (Price 8d.)

701. 1887.—S. Z. De Ferranti. Electrical meters. (Price 8d.)

702. 1887.—S. Z. De Ferranti. Dynamo electrical machines. (Price 11d.)

717. 1887.—W. B. Sayers. Disc dynamo electric machines, &c. (Price 8d.)

800. 1887.—J. B. Willis. Electric telegraph apparatus. (Price 1s. 3d.)

831. 1887.—M. Immisch. Converting alternating currents into continuous ones. (Price 8d.)

2,959. 1887.—H. C. Chocqueel. Electric alarms. (Price 8d.)

3,878. 1887.—H. Boardman. Electric alarm clocks. (Price 8d.)

3943. 1887.—W. H. Douglas. Measuring electric currents. (Price 8d.)

4,138, 1887.—A. C. Cockburn. Safety devices in electric circuits. (Price 8d.)

8,329, 1887.—W. E. Langdon. Electrical signalling apparatus for railways. (Price 8d.)

11,923, 1887.—C. L. R. E. Menges. Plates for primary or secondary electric batteries, &c. (Price 8d.)

14,768, 1887.—E. M. Dorman and R. A. Smith. Switches for making and breaking circuits conveying electric currents. (Price 8d.)

16,351, 1887.—A. Owen. Electric bells. (Price 8d.)

16,376, 1887.—C. B. and R. D. Noble. Electric arc lamps. (Price 8d.)

17,157.—H. H. Lake (Whitten). Galvanic batteries. (Price 6d.)

COMPANIES' MEETINGS & REPORTS.

The Submarine Telegraph Company.

The half-yearly meeting of the proprietors in this Company was held at the office of the Company, 2, Throgmorton-avenue, London-wall, on Tuesday last, the Hon. H. R. Brand presiding.

The Secretary (Mr. S. M. Claro) having read the notice convening the meeting,

The Chairman said: Gentlemen, I presume that I may, as usual, take the report as read. In moving the adoption of the report and accounts I have in the first place to express the regret of the Board at the absence of our Chairman, Sir Julian Goldsmid. He is passing the winter abroad, and he desires me to state that it has been a great disappointment to him to find that he is not able to attend here to-day. In his absence the Board have deputed me to take the chair because I happen to have been associated with the Chairman in negotiations with the English Government on matters which seriously affect the interests of this Company. I need not detain you on the accounts for the present half year. They are very simple and normal in their character. Perhaps the only item that calls for any special remark is that of salaries and wages, which show a considerable increase. The moiety of that increase is explained by the fact that there have been 27 pay days, whereas the takings have been for only 26 weeks. The balance of that increase is explained by the necessary and inevitable increase in the salaries. There is nothing unusual in the character of the business, which has been very steady and subject to very little fluctuation. On the one hand there has been a considerable increase in the number of messages, but on the other hand there has been a shrinkage in the number of words per message. The result of that is that there has been a slight increase in the amount of receipts this half year as compared with the corresponding half of last year. The accounts, however, will enable the Directors to recommend a dividend at the rate of 15½ per cent. per annum, to allocate the usual amount to reserve fund, and to carry forward a small sum. Now I am quite sure that your minds at this meeting are occupied with matters affecting the existence of the Company, and therefore I will shortly inform you of our position in respect to the renewal of our concessions. You will remember that on two or three of the last occasions of our meeting the shareholders, the chairman deprecated any discussion upon this question. You were, however, quite willing to follow that advice, and it was obvious that no advantage could be gained by making public the course of our negotiations with the French Government. At the same time I think I am right in saying that the Chairman, in guarded language, expressed an expectation that we should be successful in obtaining a renewal of this concession from the French Government. Well, I have to say that the Chairman was perfectly justified in expressing that opinion. We had actually received an intimation from the French Government, of which M. Rouvier was the Premier, that the renewal of the concession would be granted to us by the French Government for a term of years upon terms agreed upon between the Government and the Company, when the English Government interposed, and requested the French Minister to defer signing that agreement until he had had an opportunity of considering an alternative policy of the English Government to place the administration and working of the cables between England and Belgium and between England and France in the hands of the Governments of the respective countries. Well, now, I think it right to say here that our success so far was due to the energy and the ability of our Chairman and of Sir James Carmichael, one of our colleagues, ably seconded as they were by Count Dillon in Paris, who spared no effort in the interests of the Company. I think it right that the shareholders should know this, because these gentlemen did all that was possible, and they could not by any chance have foreseen the very strange—I think the very strange—action of the English Government. We consider that the action of the English Government is a breach of faith with the Company. We have pressed this point on their attention, but Governments have no consciences. In a matter of this sort they seem to be all alike. We have now a Chancellor of the Exchequer who is a financier and a man of business, and he has seen, as he thinks, an opportunity of obtaining what he believes to be a profitable business upon easy terms, and has seized that opportunity; but I think he can only effect his object at the sacrifice of your interests. Well now, if it were said that this was for the public advantage something might be said for the policy adopted, but it is not for the public advantage. The public can get every advantage from this Company that the Post Office could give them. It is a mistake to suppose that the tariffs have been settled by this Company; they have been settled by the Governments with the agreement of the Company. The Company have been always anxious to meet the wishes of the Government in this matter, and of course they would not object to a reduction of tariffs so long as it did not preclude the Company from carrying on their business in a profitable way. The policy of the Government is not likely to encourage or stimulate enterprise. Our late Chairman, Sir James Carmichael, and the other concessionaires were the pioneers of submarine telegraphy in this country. I am right, I believe, in saying that the Calais cable of this Company was the first cable ever laid under the sea. The enterprise was at the time considered to be a mad and hopeless one, yet the Company, instead of failing, succeeded, and now they are required to yield up the result of their skill and enterprise. Well now, I have said that this is a gross breach of faith on the part of the Government, and I will tell you why I say so. In 1868, when the English Government purchased the inland telegraphs, this Company entered into a working agreement with the Government for the transmission of messages along the land lines. Ten years later the Government—that is to say, the Post Office—being desirous of better terms entered into a fresh agreement with this Company, by which on the one hand the Government invited the Company to

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obtain a renewal of the concessions from the French and Belgian Governments, and on the other hand the Company undertook, as soon as they obtained a renewal of those concessions, to give terms to the Post Office more advantageous than those fixed by the agreement of 1868. Well now, the Government allege that this agreement must be null and void by the failure of the Board to obtain an earlier renewal of the concession from the French Government and by lapse of time. Now, in the first place I have to say that our failure to obtain an earlier renewal of the concession from the French Government was not owing to any fault of the Board, but to the fact that we were always met with a refusal by the French Government to enter into the consideration of this matter until the time of the expiry of the old concession had arrived. But apart from this, the lapse of time and the failure to obtain an earlier renewal of the concession were no justification for the action of the English Government. They entered into the agreement of 1878. They invited us to obtain a renewal of the concession from the French Government, and from that time until last November they never intimated to the Company that not only was the agreement cancelled but that they intended actively to oppose the renewal of our concessions. I contend that for all those years they led the Board to believe—and the Board acted on the belief—that the position of the Government would be one of benevolent neutrality. We have urged this point on the Government, and have intimated to them that if they insist upon this policy they ought to have regard to these circumstances in fixing the price to be paid to this Company. We have done this because it is obviously absurd for the Company to discuss any longer the question of policy with Her Majesty's Government. We understand that the Cabinet has decided the question of policy, and so far the question must be considered to be settled as regards the English Executive. There remains, of course, the decision of the French Government, who have come to no conclusion on the matter, and there remains also the decision that the English Parliament will come to on the subject. I hope for my part that some efforts will be made in Parliament to point out the extreme danger of these extensions of Government business. Fortunately there are very few technical departments of the English Government. I have had experience in some of them. The course of action in those departments is always the same. The permanent officials believe, or profess to believe, that they can carry on business better than it can be conducted by private enterprise. In that they are mistaken. They are for ever endeavouring to extend the area of their departments, and they put forward such proposals on the ground that they will be for the public advantage, so that the Minister making himself responsible for these extensions will get a great access of popularity, whereas the only practical result is a large increase of the pension and salary lists, and probably an increase in C.B. and K.C.B.-ships. It seems that the Treasury are quite incapable of resisting this tendency, although they know, from experience, what is the result. They have had a bitter experience in the past. There is an enormous deficit upon the telegraph account. Take the Parcels and Samples Post of the Post Office, and it will be found that that department publishes no balance-sheet. I think that some member of the House of Commons ought to call for a return of the Parcels and Sample Post. If they got that return it would be found that the business is conducted at a ruinous loss to the taxpayer, and if they absorb the telegraph companies they will soon be conducting that business not at a profit but at a loss. As I have said before, it is useless for us to discuss the question of policy with the English Government. If they obtain the assent of the French Government, the only question between the Company and the Government will be one of terms. I cannot express myself as being very sanguine that the terms will be such that you and the Board will consider highly satisfactory ; but I am happy to say that we have got the Government to assent to two principles for which the Directors have contended, and to which they attach the utmost importance. I do not think I ought to say more at the present moment. I can only ask you to have patience, and to be assured that the Directors will do their best to guard your interests, and that so soon as we approach nearer to a settlement we will call you together to obtain your decision. He concluded by formally moving the adoption of the report and accounts.

The Hon. Ashley Ponsonby seconded the motion.

Mr. King thought that the Chairman had so ably stated the position of matters that any remarks a shareholder might make must be almost superfluous. Nevertheless, having for many years been interested in this Company, he could not help calling to their recollection a remark he had made at one of their meetings in bygone days to the effect that if they did their work well, and served the country well, he for one would have nothing to fear as to the renewal of the concession. He believed at that time that it was quite impossible for a Company that had manifested the indomitable enterprise of this Company, and that had brought to a practical use to the country at large such an invaluable invention as submarine telegraphy, to be deprived of its rights. This was the pioneer company, and if it had not been for the courage of its originators submarine telegraphy might have been unknown to the commercial world. For that reason he felt so certain that they should at least have justice at the end of the concessions that he ventured to make the remark—and he would still fain believe it—that they would have justice done to them by the English Government. If the British Government were desirous to make the property their own, they must in all conscience give the company a fair and reasonable remuneration for taking it into their own hands. As had been intimated by the Chairman, there was the Parliament of the country, before which they might lay their claim, and he for one would await with anxiety its verdict. After the enterprise displayed by the promoters of the Company in the earlier stages of its existence, it was indeed a very poor reward to them to find that the Government, by intimation that had been given through the press and before the negotiations had ripened, had published information which had considerably damaged the property by depressing its value in the market, and very unnecessarily aggravated their position.

Mr. Soden said he was sure that the shareholders must have listened with great satisfaction to what had been said by the Chairman, who he believed would have their entire sympathy. He thought he might show his fellow shareholders in what way they might support the Board. He would say very little about the policy of the Government in their endeavour to acquire submarine communication between the Continent in the same way as they had acquired the inland telegraphs within the limits of the United Kingdom ; but he was completely staggered when he heard, if rumours were true, of the means adopted by the English Government to induce the French not to renew the concession of the Company. He was quite sure that the English taxpayers would not submit to have their money spent in backing up the credit of a foreign Government, and in allowing them to have more than their fair share of the profit of the undertaking. Assuming it to be a right policy, in what way could they as shareholders assist the Board and see that they got a fair and adequate remuneration for their business and property ? He would make this remark in passing with regard to the policy of the Government. It did seem to him that it would have been a more prudent thing if the Government, instead of embarking on risks for foreign Governments by the acquisition of submarine telegraphy, considering the present state of the Continent if war were to break out, were to leave such matters in the hands of a Company like theirs, which might act as a buffer between this country and foreign Governments in the event of any complications. Assuming that Parliament sanctioned this policy, however, and that it was a right thing for this country that it should acquire the business and property of submarine cables between this kingdom and the Continent, they must look around and see whether they had not some supporters in the same interests as they had. He ventured to think that they had. He read with some regret the fact that Her Majesty's Government had arbitrarily given notice of their intention to revoke the license that they now held and had held for nearly thirty years for the use of the foreshore. He would call the attention of his fellow shareholders to the fact that every cable company carrying on the business of submarine telegraphy between this country and every part of the globe held its title in the same way as this Company. The Anglo-American, the Eastern, and other companies were in the same position. He would point also to this fact—and he was well within the mark—that the cable mileage of all the companies carrying on the business of submarine telegraphy beyond the limits of the United Kingdom was over 100,000 miles, a greater mileage than that of the railways of the United Kingdom; and of course it was obvious that millions of money had been embarked in the industry. Now, had they not any supporters to help them? It might appear that the Government, if they saw fit, for any purpose of their own, looking at the way in which they had obstructed the Board in their endeavours to get a renewal of their concession, would give to any one of those companies three months' notice of their intention to revoke its license. It would mean the destruction of their trade and the loss of their capital should this policy of the Government in its integrity be carried out. Therefore, let the shareholders combine with those companies ; let them show to those companies that they were exactly in a similar position to themselves. Thirty years ago they embarked their capital in this undertaking when very little was known of the science, when it cost very much more to lay cables, and when risks were run which were now thought nothing at all about. By the employment of that capital, by the skill and energy of those gentlemen who had conducted their affairs, they had created a business for themselves (because there was nobody else in the field) which at the present moment, in round numbers, was worth £150,000 a year. Was, then, the Government of this country to take and put into their pockets that annual sum, which was capable of extension, without paying the Company full and adequate compensation? If they did, they would be acting upon the principle that might was right. Let them unite with all submarine cable companies who were doing business to other places than the Continent to resist such a policy. They should then be able to demand justice at the hands of the Government. What took place with regard to the inland telegraphs ? They were really in a very similar position to themselves, and he thought this was a very important point. Speaking broadly, the inland telegraph companies, by leave of the railway companies, by leave of the canal companies, and by leave of the road authorities, laid down their posts along the side of the railways or the banks of the canals, and were subject to have their wayleave revoked by any of these interests. Now, it was said that the Government were very foolish in those days—whether they were it was not for him to say—in not going to those companies in the first instance ; but it seemed to him that because they were foolish on that occasion they were not justified in adopting their proposed policy against this Company. When it was seen that the inland companies were not to get fair compensation, what did they do ? They combined together and got it. It might be that the country paid too dearly for the telegraph system, but that was no reason why the Government should commit an act of injustice now, and therefore let them ally themselves with the other submarine cable companies, and let them show the Government that they were not to take the property of the Company without paying them adequate compensation.

The Chairman said he was obliged to the two shareholders for their speeches, and especially for the suggestion with regard to the interests of the other companies. It was certainly true, he thought, that the blow aimed at this Company was one which showed that the other companies were exposed to a similar danger.—The motion was agreed to unanimously.

A resolution was afterwards passed declaring the dividend recommended at the rate of 15½ per cent. per annum.

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On the motion of Mr. SODEN, seconded by Mr. KING, a vote of thanks was accorded to the Chairman and the Directors for their conduct of the Company's business during the past half year.

The CHAIRMAN briefly replied, and repeated his expression of the hope of the Board that the shareholders would do everything in their power to strengthen the hands of the Directors in their efforts to see justice done to the Company.

The proceedings then terminated.

Taunton Electric Lighting Company (Limited).

The first annual general meeting of the shareholders of this Company was held last week at the Castle Hotel, Taunton, under the presidency of Mr. W. H. Fowler.

The CHAIRMAN moved and Councillor POTTER seconded the adoption of the following report of the Directors:—

The number of shares allotted is 873, on which the sum of £4,365 has been received, including the amount allotted on account of the purchase of the business. The number of private customers is now 20, besides the town lighting, and the number of arc lamps let at a rental is 65, besides the incandescent lamps in use, numbering 200. The accounts for the year show a profit of £315. 15s. 5d. The Directors recommend that a dividend of 5 per cent. be paid, free of income-tax. This will take £191. 19s. 6d., leaving a balance of £123. 15s. 11d. to be carried on for a reserve and depreciation account. In addition to the Taunton business the Company has carried out temporary installations at Bath, Weston-super-Mare, and Exeter. Deputations from various places have visited Taunton during the past year for the purpose of inspecting the Company's works, machinery, and the lighting arrangements of the town, the general testimony being that it is one of the most successful installations yet carried out in the United Kingdom. The machinery has been maintained in excellent working order, the repairs being charged to income account. As the demand for the light increases, it is expedient to lay down more plant and machinery, and to enable the Directors to do this they hope that the public generally will take up more shares to increase the capital available for this purpose. Two of the Directors retire by rotation, and are eligible for re-election.

After some general discussion the report was agreed to.

Mr. Sampson and Mr. Lewis, the retiring Directors, were re-elected, and Mr. J. A. Winter and Mr. C. E. Lance were appointed additional Directors, the number being increased to nine. Mr. Massingham was re-appointed Managing Director, and Mr. A. Goodman auditor.

Mr. BALE proposed the re-election of Mr. Massingham as managing director. The position of Mr. Massingham upon their Board was a unique one. He discharged the onerous and important duties of a managing director in a very satisfactory way to the shareholders, and he was sure the dividend that had been declared that night as the result of the first year's working would meet with the approval of every shareholder. To this result Mr. Massingham's able management had very largely contributed.

The proceedings then terminated.

India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

Report of the Directors for the year ended December 31st, 1887, to be presented at the twenty-fourth ordinary general meeting of the shareholders, to be held at the Cannon-street Hotel, on Tuesday, the 28th inst., at 12 o'clock:—

The accounts show the net profit for the past year to be £13,174. 10s. Adding £37,955. 13s. 5d. brought forward, and deducting £20,800 interim dividend paid in July, there remains a disposable balance of £30,330. 3s. 5d. The Directors recommend the distribution of a dividend of 10s. per share, free of income tax, amounting to £20,800, making, with the interim dividend, a total payment for the year of 10 per cent., and leaving £9,530. 3s. 5d. to be carried forward.

The Company has done an increased general business in the year; but competition and cost of raw materials have also increased, and have kept down the rate of profit on manufactured goods. The little submarine cable business open to tender has been keenly competed for. The contracts secured by the Company have given inadequate employment to its cable works and steamers during the year; and the expense of the submarine telegraph engineering staff and plant, though reduced as far as prudently could be, has borne heavily on the general earnings. To these causes the Directors attribute the reduction in profit shown in the accounts. In order, however, to equalise dividends to some extent, and believing that they may hope for better results in the future, they have drawn upon the floating balance of undivided profit, still leaving a substantial amount to carry forward to the current year. The Company's works, machinery, and vessels are all in first-rate order.

Mr. Silver and Mr. Bannatyne, the Directors retiring by rotation, offer themselves for re-election.

Brighton Electric Light Company (Limited).

Second annual report of the Company's operations for the fifteen months ended 31st December, 1887, to be presented at the third ordinary general meeting of the shareholders to be held at the offices of the Company, Gloucester-road, Brighton, on Saturday, the 18th inst., at 5 p.m.

1. The Directors submit to the shareholders the report of the operations of the Company from the 1st October, 1886, to the 31st December, 1887.

2. The capital account has, during this period, been augmented by the sum of £2,100, which has enabled the Company to increase their engine power and dynamo capacity, and to largely extend the circuits. The profit and loss account, after writing off the special legal expenses of the year, and an ample sum for depreciation of plant, shows a balance of profit for the fifteen months of £721. 16s. 6d., which, with the small balance brought forward from last year's accounts, makes the sum to the credit of profit and loss account £729. 0s. 11d., and the Directors recommend the following appropriation of it:—

	£	s.	d.
Dividend of 5 per cent. per annum on the share capital	568	16	10
Liquidation of the balance of the preliminary expenses account	89	16	2
Carried forward to next year's profit and loss account	70	7	11
	£729	0	11

3. There has been a steady increase in the Company's business during the period under review. The mains belonging to the Company now extend a distance of fifteen miles, reaching westward as far as King's-gardens, Hove; eastward as far as Eastern-terrace, Kemp Town; and northward as far as Hanover-crescent, Lewes-road.

4. One reason of this increase of business, and of the probability of its further development, is the extension of the Company's mains into Hove. As that district consists almost entirely of the residences of the wealthy, a practically unlimited field is thereby opened to the Company.

5. The Directors have considered it desirable, in order to be in a position to cope with their increasing business, to still further increase the dynamo power, to extend the Company's circuits, and to gradually place "converters" in all the premises lighted, by means of which it will be possible to turn lights on and off one by one when required.

6. The cost of the proposed extensions will be about £2,000, and the Directors propose to cover this sum by a further issue of share capital. Preference will be given to applications received from residents in Brighton and Hove, especially from those who are customers of the Company, as the Directors are anxious to widen the local interest in the concern.

7. The contemplated addition to the plant will bring up the total dynamo capacity to over 2,500 sixteen candle-power incandescent lamps, the present engine-power being capable of driving dynamos for 3,500 lamps; so that the capacity of the plant can be enlarged to this extent by the addition of new dynamos at any time when required.

8. The nature of the improvement in the Company's business may be seen by the following statements:—

(a) Lights in operation on:—

	Arcs.	Incandescents.
October 1st, 1885	34	516
,, ,, 1886	27	875
December 31st, 1887..........................	34	1,372

(b) Quantities of electricity supplied from the works during the past fifteen months, as compared with corresponding months of previous year

UNITS SUPPLIED.

1886.	In former period.	In present period.	Percentage of inc.
October......	1,269	2,633	108%
November...	2,117	2,984	41
December...	2,446	3,175	30
1887.			
January ...	2,138	3,111	46
February ...	1,587	2,180	38
March	1,190	1,936	63
April.........	1,035	1,639	58
May	971	1,031	7
June	703	1,016	45
July	701	1,093	56
August	1,462	1,845	26
September..	1,846	2,909	63
October ...	2,633	3,958	50
November...	2,984	5,427	81
December...	3,175	6,372	101
Totals...	26,257	41,309	56%

9. It will be noticed that, whereas the total business shows the satisfactory increase of 41,309 units as compared with 26,257 in the former period of fifteen months, the most recent improvement is still more marked; the units consumed in December, 1887, being 6,372, as against 3,175 in December, 1886, and the consumption in the quarter ended December 31st, 1887, 15,757 units, as compared with 8,795 units in the corresponding quarter of 1886.

10. In view of these figures the Directors feel confident that, with the proposed additional machinery at their command, they will be able, during the current year, to considerably augment their gross receipts, and as the expenses will not grow in anything like the same proportion, a substantial improvement in the profits will in their opinion result.

12. Mr. Arthur Wright, who, while in the employ of Messrs. Hammond and Co., started the works at Brighton in conjunction with Mr. Robert Hammond, and who has brought them to their present state of efficiency, has continued to act as managing director; and the thanks of the shareholders are due him for the highly satisfactory manner in which he has conducted the business of the Company during the period under review.

13. He reports that the engines and dynamos have continued to give satisfaction, and are at the present time in thoroughly good working order. There has not been one single breakdown of the machinery during the fifteen months. The whole installation is in a much higher state of efficiency than it was at the date of the last report.

14. The meeting will elect an auditor or auditors for the ensuing year.

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Swan United Electric Light Company (Limited).

Fifth annual report of the Directors, to be presented at the ordinary general meeting of the Company, to be held at the Cannon-street Hotel, on Tuesday, the 28th inst., at 12 o'clock :--

1. The accounts presented are for the year ended September 30, 1887.
2. The business has grown, and has resulted, after paying all current charges, and making fair allowance for depreciation of plant and machinery, in leaving a sum of £7,554. 11s., which the Directors recommend shall be applied to the writing off of £5,834. 3s. 1., the amount which stands against profit and loss, carrying forward £1,720. 7s. 11d.
3. The Directors have resumed negotiations with the Compagnie Continentale Edison, with a view of arriving at an equitable settlement in the countries in which they hold patents in connection with electric lamps. Should these negotiations result in any plan which the Directors regard as beneficial for the Company, they will call a special meeting of the shareholders.
4. In their last report the Directors stated that they were led to believe that a decision in the patent suit would shortly be given by the judges in the Court in Berlin. The case has dragged on during the year, but judgment has not yet been delivered.
5. Competition is very keen on the Continent, but the Swan lamp is undoubtedly the best in the market. The sales have increased during the year considerably, and the demand for lamps during the winter months has been largely in excess of previous years.
6. The Directors who retire by rotation are Mr. F. R. Leyland and Mr. W. C. Quilter, M.P., who, being eligible, offer themselves for re-election.
7. Messrs. Quilter, Welton and Co. will offer themselves for re-election as auditors.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 3rd February amounted to £2,730, and for the week ended February 10th to £3,856.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY. - The traffic receipts of this company for the week ended February 10th (after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company) were £2,559.

NEW COMPANY REGISTERED.

ECLIPSE ELECTRIC LIGHTING SYNDICATE (LIMITED).—Registered by Ernest Wood, 4, Broad-street-buildings, E.C., with a capital of £20,000, divided into 20,000 shares of £1 each. Object, to carry into effect an agreement dated February 4, 1888, and made between John Garford, of the one part, and Willoughby Hamilton Tower, as trustee on behalf of the company, of the other part, to purchase and acquire the inventor's letters patent, &c. ; to carry on business as an electric light company in all its branches. The first subscribers are :—

	Shares.
J. Garford, 3, Vernon-chambers, W.C.	1
J. Robinson, 60, Gresham-street, E.C.	1
W. H. Powes, Silverdale, Kent	1
W. C. Loe, Isleworth	1
H. Martyn, 68, Leadenhall-street, E.C.	1
H. E. Robinson, 11, Poultry, E.C.	1

The business of the company shall be managed by the board of directors, whose number shall not exceed nine nor be less than three. The first shall be Sir Charles Clifford, Bart. ; John Garford, Esq. ; and Valentine Robinson. The qualification of a director shall be the holding in his own right 200 shares of £1 each, and by way of remuneration they shall be paid for their services the sum of £150 per annum. The regulations of Table A in the first schedule to the Companies Act, 1862, do not apply to this company.

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State price and condition to the PUBLISHER of the *Electrician*, 1, Salisbury-court, Fleet-street, E.C. (Telephone 2714.)

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Feb. 15, 1888.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending Feb. 15, 1888. Highest.	Lowest.
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American ......xd	40 41	3 5 6	Jan., Apr., July, Oct.	40¼	39½
2,614,820	Stock	20/0	Do. Preferred ......xd	66 67	3 19 9	„ „	66⅞	66
2,614,820	Stock	nil.	Do. Deferred	14 15	...	February	14⅞	14½
130,000	£10	3/0	Brazilian Submarine	11¾ 12	4 18 0	Mar., June, Oct., Dec.	12	11¾
16,000	10	8/0	Cuba ......xd	12¼ 12¾	6 3 2	February and August	...	...
6,000	10	10/0	Do. Preference ......xd	18 19	5 5 3	„ „	...	...
			Direct Spanish	3½ 4	...		...	...
6,000	5	5/0	Do. Preference	8½ 9½	...	April and October ...	...	...
60,710	20	2/0	Direct United States Cable	8¾ 9½	4 5 4	Jan., Apr., July, Oct.	9⅛	...
380,000	10	2/6	Eastern Telegraph	11½ 11¾	4 15 8	„ „	11½	11¼
70,000	10	3/0	Do. 6 per Cent. Preference	14¼ 14¾	4 1 4	„ „	14⅝	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	3 18 0	February & August	...	...
250,000	10	2/6	Eastern Extension	12¼ 12½	4 15 8	Jan., Apr., July, Oct	12½	12 5/16
22,050	10	5/9	German Union	8¾ 9¼	6 6 3	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅝ 5⅞	4 18 0	Jan., Apr., July, Oct.	5⅞	5 11/16
178,992	10	3/0	Do. 6 per Cent. Preference	13⅜ 13⅝	4 8 0	„ „	13 9/16	13 7/16
150,000	10	5%	Great Northern	13¾ 14¼	5 5 6	Jan., July, and April	...	...
17,000	25	5/0	Indo-European	38 40	6 5 0	April and October ...	39¾	...
			London Platino Brazilian	4½ 5	...		4 13/16	...
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October ...	8¼	7¾
338,225	Stock	12%	Submarine ......xd	135 145	9 6 8	February & August	...	...
30,000	10	6/0	West Coast of America	5¼ 5¾	4 11 3	January and July ...	5 9/16	...
			Do. Debentures	111 116	...		114	...
88,321	10	nil.	West India and Panama	¾ 1	...	—	13/16	¾
34,563	10	9/0	Do. 1st Preference	9½ 10	7 10 0	April and October ...	10	9¾
45,181	15	3/9	Western Brazilian	9 9½	7 15 6	March & September	9	8 15/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 104	5 15 5	March & September	102¾	102
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	7/16 15/16	5 9 0	Yearly	...	...
			Oriental	¼ ½	...		...	...
80,000	£5	5/0	United Telephone	13 13½	5 6 0	June and December	13 5/16	12⅞
			United River Plate Telephone	4¾ 5¼			...	...
			ELECTRIC LIGHT.					
	5		Anglo-American Brush (£4 paid)	3¼ 3¾	...		3¾	3¼
23,692	5	nil.	Do. (fully paid)	4¼ 4¾	...	February & August	4⅝	4¼
79,934	5	nil.	Swan United (£3. 10s. paid)	1⅝ 2⅛	...		2⅛	1¾
312,000	¼	0/1½d. '86	Maxim-Weston	3/16 5/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction	39 40	6 3 0	March and July	39½	39
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	17 19	7 18 0	February & August	18⅛	17½

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 510.—Vol. XX. FRIDAY, FEBRUARY 24, 1888. Price 4d.

NOTES.

We deal with the general question of the City lighting fiasco in our leading article, but we should like in this place to ask for some further information (if this be not too bold) about the Maxim-Weston 450 candle-power arc lamp. It appears that this company are willing to supply 800 of these lamps for the sum of £3,875 per annum—that is, a little less than £4. 17s. 0d. per lamp. Now, the lighting is to be from sunset to sunrise, which, allowing nothing for fogs, is equivalent to 4,300 hours per annum. At £4. 17s. 0d. per lamp, this makes 0·27d. per lamp-hour, which we should have thought would have been somewhere about the cost of current *alone*. Or, taking another view, this figure very nearly represents the cost of carbons for a Brush 2,000 candle-power lamp; but we may assume that for the smaller Maxim-Weston lamp the cost is less than one-half this, or, say, ⅛d. per lamp-hour. We have, then, a trifle over ⅛d. per lamp-hour left, and out of this the company will have to pay the whole of the central station charges, to say nothing of office expenses, directors' fees, &c., &c. If this is, indeed, a *bona fide* offer on the part of the company we greatly fear that it is the result of some miscalculation, such as that which seems, if local reports are correct, to have occurred in connection with their contract for the Brighton Pavilion lighting.

The Submarine Telegraph Company, besides being unlucky in its recent negotiations with the French Government, has been equally unfortunate in creating enemies on this side the Channel, or at all events in not taking pains to secure friends. The management seems to have gone on its own way in a rather blind fashion, regardless of the chances which 1889 would bring, thinking apparently that if France was made easy all would be well. The result is that not only are the Governments of Great Britain, Germany, and Belgium arrayed against the monopoly, but the British press is distinctly hostile. With regard to the latter a great deal of heedless and ungenerous language is used about the Company, its rich earnings in the past being treated as a sufficient reason for summarily extinguishing them altogether.

As to this we would remark that, although on public grounds the cables connecting England with the continent of Europe should no longer remain in private hands, the process of transfer to the respective Governments involves not merely the termination of a monopoly, but the extinction of its business even as a competitor. The lapse of a monopoly does not usually mean this, any more than the lapse of a patent means the compulsory winding up of the patentee. Except for a long concession of exclusive rights the cables to France would never perhaps have been laid. That the monopoly is doomed seems to us an international necessity; but that the company is doomed as well is a circumstance wholly exceptional; and this fact entitles the shareholders to more liberal treatment than public opinion at present seems disposed to afford.

The London Electric Supply Corporation (*née* "The Sir Coutts Lindsay Electric Lighting Company") are at length showing signs of abandoning the reserve with which (for easily understood and very proper reasons) they have hitherto conducted their operations. As may be seen in another column, they even go so far as to speak openly of their projected station at Deptford, where within twelve months they hope to have a 200,000 light plant installed. This company have our heartiest wishes for the success of their enterprise, and we trust that nothing will arise to check the rapid progress which they are anticipating.

The subject of working transformers in series connection has not, since the early failures, received the attention which it deserves, and we are glad that Mr. Bernstein has taken occasion to bring the question before the Society of Telegraph-Engineers and Electricians. It is quite probable that in the adjourned discussion which will have taken place before these lines meet our readers something more may have transpired upon this subject, but, meanwhile, we may offer one or two remarks upon some points which we do not remember to have seen elsewhere referred to. In addition to the advantages of this method of working, which are common to all constant-current systems, there is also an important element of safety which distinguishes the series from the parallel transformer. If we short-circuit the secondary coil of a transformer joined in parallel upon the mains, we get a tremendous rush of current through the primary. Of course, in practice, we assume that no harm would be done, because the fuse in the secondary circuit would immediately melt; and even if this fuse hung fire the primary coil would still be protected by its own fuse. But while this is perfectly true we ought, perhaps, to recognise more fully than is usually done that the fusible wire is a drastic remedy, for which electric lighting has at times to pay for heavily by the trouble and annoyance which its action

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occasions. In fact, we quite agree with Mr. PREECE, who, on another page, speaks of fusible cut-outs as "effective, but somewhat barbarous." Now, with a series transformer an accidental short-circuiting of the secondary is, of course, unable to increase the current in the primary, and, in fact, owing to the enormous lag occasioned, it need not necessarily increase the output of the secondary at all. We should hardly like at the present moment to say that fuses may be alogether dispensed with on such a circuit, but it is certain that their use may be very much restricted without in any way decreasing the safety of the installation.

IN Mr. KAPP's paper the question of series transformers is, however, briefly dismissed with a remark to the effect that in such a case a movable core is obviously necessary to regulate the secondary terminal potential—which, of course, is tantamount to saying that the thing is impracticable. But we venture to think that the above statement is not entirely obvious. It is, for instance, *possible*—though certainly not advisable—to obtain regulation for a series transformer without undue loss of energy by means of an automatic regulating mechanism. A very ingenious device of this description was made some time ago by Mr. F. H. NALDER. Mr. A. WRIGHT, of Brighton, has, we believe, done much the same thing, but it is, of course, fully recognised, even by the inventors themselves, that regulation by automatic mechanism, even though the core is untouched, is inadmissible as a practical device. Next there is the plan of compound winding, as proposed by Profs. AYRTON and PERRY, of which a diagram will be found on another page. But the practicability of this arrangement is hardly yet assured. After this we have the "impedance" coils of Messrs. SHARP and KENT, which were referred to in Mr. MACKENZIE's paper. A full description may also be found in *The Electrician*, April 29, 1887. This device seems to fulfil its purpose quite satisfactorily, and though we believe that from theoretical considerations it has been shown that its action is necessarily limited in range, yet in practice we understand that no such limit is apparent. These are points on which we should be glad of further information. Once more, if we adopt the view which some people hold (Mr. BERNSTEIN amongst others), that a house may be cheaply and conveniently wired by taking a separate pair of leads to each lamp from a common switch-board (where all the fuses would be placed), then we may, if we like, have a separate secondary coil for every lamp, subdividing the cores to the same extent. This arrangement will evidently be perfectly self-regulating with a constant primary current, but it is also evident that it involves a somewhat more costly transformer, neither is it applicable for large sub-station transformers, such as Mr. KAPP advocates. Lastly, it may be shown that a series transformer would be perfectly self-regulating if there were no self-induction in the secondary coil. We cannot, of course, do away with the coefficient of self-induction without, at the same time, cancelling the mutual induction; but, as Mr. SUMPNER has shown, it is theoretically possible to compensate self-induction by the addition of capacity. If, therefore, we had a condenser of suitable dimensions joined as a shunt across the terminals of the secondary we ought, apparently, to get self-regulation. It may be that the successful series transformer system has yet to be devised, but we feel tolerably sure that the advantages enumerated by Mr. BERNSTEIN (whose speech will be found in another page), together with those above mentioned, are amply sufficient to make the question worthy of the attention of electrical engineers.

AN esteemed provincial contemporary, the *East Anglian Times*, is distinguished above all its compeers by a most laudable enthusiasm for the electric light. A few days since Messrs. PARIS and SCOTT, the well-known firm of electrical engineers at Norwich, invited the members of the Ipswich Scientific Society to visit their works, and this leads the representative of the above-named journal to write a really remarkable article on "The Making of Electric Light." The reporter first achieves distinction when he describes the building of an armature—"a curious cylinder," with "multitudinous iron discs," "numberless longitudinal grooves," and miles of copper wire. But this is nothing to his description of the machine at work:—"The "cylinder runs through the centre of the magnet, and "is set revolving. What then happens is almost beyond "description; but the magnets produce electrical currents "one way, and the cylinder, technically called the armature, "makes them in another direction. The rival currents, as it "were, fight and foster one another, increasing and developing "by the friction and competition. The cylinder wins the day, "catches hold of the electricity, and carries it away into won-"derfully built-up contrivances of copper and mica, called com-"mutators. These revolve with the cylinder at a terrific speed, "and give off the electricity into threads of copper bound "together, technically called a brush. From the brush the "electricity runs into the wire, and thence to the lamp."

THE incandescent lamps of high candle-power which can now be obtained both from the Edison-Swan Company and from Messrs. Clarke, Chapman, Parsons and Co., are rapidly coming into extended use. At the Forth Bridge Works they have almost entirely replaced the Lucigen light, and they are also largely used for indoor lighting in the workshops. In some of the earlier specimens of these lamps which came under our observation the glass blackened very quickly, but this defect appears now to have been almost entirely overcome. There can be very little doubt that these lamps will take a very important place indeed in the future of electric lighting.

The Barcelona Exhibition.—The 28th inst. is the latest date at which applications will be received for space at this Exhibition.

Sofia, Bulgaria.—The Municipal Council of this city have offered a premium of 5,000fr. for the best scheme for lighting the town, either by gas or electricity.

The Khotinsky Lamp.—The Khotinsky incandescent lamp is rapidly coming into use in France. These lamps are made at Rotterdam, and the process of manufacture is kept strictly secret.

Tenders Asked For.—We would direct attention to an announcement which will be found in another column to the effect that the Council of the City of Wellington, New Zealand, are open to receive tenders for lighting that city by electricity.

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Kensington.—The sub-committee of the Kensington Vestry have advised the works committee of that body to postpone a decision on the order sought by the Kensington Court Electric Light Company, in order to give rival companies time to present their plans.

Shop Lighting.—The grocery and other departments of Messrs. Crisp and Co., Seven Sisters-road, N., are being fitted with the electric light by the Maxim-Weston Electric Company. This company has now successfully lighted the premises of several well-known firms in the grocery and provision trades.

Spanish Tender for Telephone Service.—The *Madrid Gazette* of February 14th contains a Royal Order authorising an invitation for tenders for the establishment and working of a telephone service in Felanitx (Balearic Isles), subject to the conditions published in the official journal of 15th June, 1886. Tenders are to be adjudicated upon on March 17th next.

The Mexican Telegraph Lines and the Western Union.—We recently referred to rumours current in Mexico that the Western Union were contemplating the acquisition by purchase of telegraph lines in Mexico. Advices just received from the City of Mexico now report that Mr. Thos. J. Eckert, general manager of the Western Union, has telegraphed denying the rumour.

Spanish-Balearic Cable.—With reference to the submarine cable between Spain and the Balearic Isles, which is reported to have been interrupted for some time past, we learn from *Industrias é Invenciones* that the Spanish Government contemplates the laying of a new cable. It is expected that the work, if definitely decided upon, will be given to a foreign company.

The Electric Lighting Act.—In the House of Commons Mr. Barclay has given notice that he will ask the President of the Board of Trade in how many cases the powers obtained by Provisional Orders under the Electric Lighting Act of 1882 have been actually exercised; why so little progress has been made with electric lighting under the Act of 1882; and whether the Government intends to amend the Act, with the view of encouraging the development of electric lighting.

Lighting of the Royalty Theatre, Glasgow.—Mr. Geipel writes as follows:—"In your last issue you state that the above theatre has been supplied with a complete installation of electric light apparatus by me. May I ask you to correct this by stating that the contractors for the supply and maintenance of the installation are the Anglo-American Brush Electric Light Corporation, my employers, on whose behalf I made the arrangements and supervised the work?"

The Electro-Harmonic Society.—This society will give its first amateur concert at St. James's Hall on Friday, March 2. This will be a "ladies' night," and we understand that it is proposed to take off the stiffness of an ordinary concert by seating the audience, as at the smoking concerts, the chairs being grouped around small tables. This innovation will, we are sure, meet with the approval of the members of the society. We trust that it will also meet with the approval of their lady friends.

Method of Saving Horses from Fires.—A New York man has invented a device to save horses in case of fire. It can be worked either by electricity or by hand. At a certain temperature a bell will ring, and the moment the bell shall ring the doors will fly open, the horses will be unhitched, and two small streams of water will strike each horse in the face. To escape the water the horses will back out of the stalls, and, once out of them, they will have an opportunity of seeing a way of escape through the open doors.

Electric Light at Marlborough House.—His Royal Highness the Prince of Wales has decided to have the State apartments and principal rooms in Marlborough House lighted by electricity, and it is expected that all the necessary apparatus will be fixed in time for the silver wedding celebration early next month. The work is in the hands of the officials of the Prince's household, who are assisted by a special staff directed by Mr. T. O. Belshaw and the Court electrician, Mr. W. H. Massey. The current will be supplied by the Sir Coutts Lindsay Company from the Grosvenor Gallery Station.

The Electric Lighting of Ships.—The new cruiser "Chicago" is now being fitted out for service at the Brooklyn Navy Yard. The electric plant is already installed, and consists of two Edison compound dynamos, each for 350 lights, driven by Armington-Sims engines. Lead-covered cables have been used throughout the ship, the total length of circuits being about 40,000ft. The cables are laid in wood casing, and Edison watertight cut-outs are fitted to every lamp, and all the switches employed are also watertight. The total insulation of the circuits is said to be about 100,000 ohms.

Electric Fire Alarms at Bristol.—At the request of Sir William King the Western Counties and South Wales Telephone Company have erected fire alarm posts at Kingston Cross and Palmerston-road, Bristol. These posts are connected with the chief police and fire station at Landport. The system is the same as that adopted by the Metropolitan Fire Brigade. The Western Counties and South Wales Telephone Company have provided this system as an experiment, and will maintain it free of cost to the borough for three months, by which time the Corporation will have been able to form an opinion whether they desire to adopt it or otherwise.

Long-Range Lighting.—As one of the most marked instances of the advantages of transformers in electrical distribution, we note, says the New York *Electrical Review*, a new station under the Westinghouse system at Edgewood, a suburb of Pittsburgh, now in successful operation. The circuit is in all eight miles long, and the distance from generators to point of distribution four miles. A No. 4 wire is used for the line, and at present there are about 500 lights in use at the distant point, but wiring goes forward as rapidly as possible for nearly 5,000 more lights. This will be, when finished, the most important illustration of long-distance distribution yet attempted, and, so far, not a hitch has occurred.

Hastings.—A long discussion took place at the Town Council meeting on Friday last in reference to the recommendation of the committee to the effect that a resolution formerly passed, refusing permission to the Electric Light Company to put up overhead wires in several streets, should be rescinded, and that the committee be empowered, if they saw fit, to grant the application upon such terms and conditions as might be agreed on. The recommendation was eventually carried. The local paper says:—"We feel that the council have acted rightly and wisely, for besides doing justice to a company which is entitled to look for consideration at their hands, they have averted what might have proved to the town a troublesome law suit."

Cable Companies: Football Victory.—A correspondent writes from Porthcurno:—"Dear Sir: A return football match was played against Penzance on the 11th, and again resulted in a victory for the United Cables by 3 to 1. Saunders kicked the goal for Penzance first half-time. During the second half the good passing of the Cable forwards won for them the game, Evans shooting the first and Raymond

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the last two goals. Team: Martin, goal; Leahy and Palmer, backs; Ernest Ash, Davies, J. B. Sweeting, half-backs; Adson, W. H. Raymond, centres; Derrick M'Lean, left wing; Walton Evans, right wing; umpire, Mr. Thorngate. Messrs. Adson and Walton represented the Western Union Cable Company, the rest Easterns or Exiles."

The Submarine Telegraph Company.—In the House of Commons, on Saturday last, in reply to questions from Sir G. Campbell and Mr. Henniker Heaton, Mr. Raikes said:—"The Submarine Telegraph Company have been informed that it is not the intention of Her Majesty's Government to agree to any renewal of the concession to them which will expire shortly. No agreement has been come to with the company as to the purchase of their plant and transfer of their undertaking; and I do not think it would be to the public interest that any statement as to the details of negotiations should be made until some definite decision shall have been arrived at. I may say, however, that the inferences suggested by the question of the hon. member for Canterbury are very inaccurate."

Messrs. E. Stanford's Parliamentary Map of the Metropolitan District.—This year's issue of the "Map of the new Railways, Tramways, and Miscellaneous Improvements for the Metropolitan District," deposited in the Private Bill Office at the commencement of the present Parliamentary session, shows by a red border the district which is sought to be covered for electric lighting purposes by the South Metropolitan Electric Lighting Company. This district is bounded as follows:—Commencing at Piccadilly, by Shaftesbury-avenue, Endell-street, Great Queen-street, Lincoln's Inn-fields, Chancery-lane, Fleet-street, New Bridge-street, Victoria Embankment, Waterloo Bridge and Road, Lower Marsh, Westminster Bridge-road, Palace-yard, Great College-street, Victoria-street, James-street, Buckingham Palace, and the Green Park.

Water-Soaked Dynamos Dried by Steam.—A few weeks ago, says the *Western Electrician*, the station of the Brush Company at St. Louis was badly damaged by fire. When the fire department left the place the dynamos were standing deep in water. Notwithstanding the difficulties in the way, the most active and energetic measures were taken to get the station in running order again. The water was drained away and then a steam radiator was placed either side of each dynamo and a tarpaulin thrown over the top, making as it were an oven for each machine. Steam was then turned on and for sixteen hours the dynamos were subjected to the heat. At the end of that time the dynamos were found to be thoroughly dried out and in condition to use again. Seven of the dynamos were found to be in perfect order and only one was found to be slightly damaged.

The Schanschieff Battery.—Her Royal Highness Princess Christian has accepted from the directors of the Schanschieff Battery Syndicate a portable electric reading lamp fitted with the Schanschieff battery. The lamp is a very handsome one, and is enclosed in a rosewood case inlaid with ivory, by Cooper and Holt. Mr. Schanschieff having explained the invention and shown the interior, the Princess expressed herself as greatly pleased at the simplicity of charging, the absence of wires, its absolute freedom from gas, smell, or risk of accident, and, in particular, with the ratchet arrangement by which the light was regulated from 1 to 10 candle-power, or totally extinguished and relighted at will. Mr. Schanschieff then exhibited one of the reversible automatic miners' lamps, in which her Royal Highness expressed much interest.

The National Telephone Company's System in Scotland.—We have received from Mr. A. R. Bennett, of the National Telephone Company, a map of central Scotland, showing the existing and projected trunk lines. The existing system extends from Forfar in the north to Ayr in the south, and east and west from Greenock to Dalkeith, and includes all the important places without exception in this extensive tract. The following are the chief lines which it is at present intended to carry out:—From Kirkcaldy along the coast line to St. Andrews; an extension eastwards from Edinburgh to Dunbar, and southwards to Galashiels and Selkirk; the opening of a second route between Edinburgh and Glasgow *viâ* Bathgate and Coatbridge; and a line from Alloa to Perth *viâ* Kinson and Newburgh. In addition to these places named these lines will serve many smaller towns and villages *en route*.

The West Metropolitan Tramway Company and Electrical Traction.—At the meeting of shareholders in the West Metropolitan Tramways Company, held on the 17th inst., the chairman (Mr. E. H. Bayley) denied a statement made in a circular issued by a shareholder named Willis that the directors had been spending money on electrical experiments. What they had done was to carry out an undertaking which they gave to the shareholders at the general meeting eighteen months ago that they would make an application to Parliament and the local authorities for permission to make use of electricity as a motive power in case it should be found advantageous for the company to do so. They had made that application, and in spite of the most tremendous opposition they had succeeded in getting the authority. If they could adopt electricity that would enable them to deal successfully with the railway competition, and to reduce considerably the working expenses.

The "Corner" in Copper.—In the French Chamber on Saturday last there occurred a scene which has often its counterpart in the British House of Commons, where inconvenient questioning is the rule and evasive answering hardly less so. M. Laur wanted to know whether the alleged combination of a French syndicate to raise the price of copper did not come under the penal provisions of Article 419. The Minister of Justice replied at some length that the combination was not proved; that copper had been going down lately, and that both rise and fall might be due to economic causes; but that it must not be supposed that Article 419 was dead because it was seldom applied; and if it were found that an unlawful combination existed to secure a monopoly of any article of merchandise "there are tribunals in France competent to apply the penal code." Then, of course, the subject dropped.

Telephones at Ventnor.—The Equitable Telephone Association has now completed telephonic communication between the ten different blocks of the National Hospital for Consumption, Ventnor, Isle of Wight. Eleven of the A type Swinton telephones are employed, and all are connected to a central exchange switch-board in the head nurse's room, so that communication between any one block of the hospital and any other can be easily effected. The wires are led along an underground passage, which connects all the blocks together. As the hospital extends over a considerable distance, and the several blocks are detached from one another, it is expected that telephones will prove a great convenience to the resident staff, and the switch-board has been arranged so as to admit of the residences of some of the medical officers living away from the hospital being connected, should this be considered advisable at some future time.

The Lancashire and Cheshire Telephone Company.—The new issue of the "Telephone Directory" of the Lancashire and Cheshire Telephone Company is a bulky volume of

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393 pp. (including advertisements). In addition to the long lists of subscribers, members in the towns and villages of Lancashire and Cheshire, much interesting information can be obtained from this volume as to the extension of the telephone system in the North. A map showing the existing and proposed system of trunk wires is included. From this map it will be seen that the district served by the company is already almost completely covered with a network of trunk wires, and, with one exception, the extensions in progress are of an unimportant character. The exception referred to is a line northwards from Blackburn, which will bring Lancaster, Ulverstone, and Barrow into the company's system. In turning over the pages of this book, it is difficult to realise that the first exchange was opened in this district little more than eight years ago.

Personal.—Mr. A. E. Kennelly (late of the Eastern Telegraph Company) is now delivering a course of evening lectures to the whole of the staff engaged at Edison's new laboratory. The lectures are spoken of very highly by the local press.—We regret to learn that M. Cornélius Herz, the editor of *La Lumière Electrique*, has left his native land, and that his speedy return is scarcely to be anticipated. According to the *Bulletin des Sociétés d'Electricité*, his departure is owing to the non-success of certain financial operations in which he had been interested. It is, however, much to be hoped that this unfortunate incident will not be allowed to have any prejudicial effect upon the valuable journal which M. Herz has edited for many years with so much ability and success.—We have to record with the most sincere regret that M. Lucien Gaulard, whose name is so closely associated with the introduction of the system of distribution by alternating currents, is suffering from mental derangement. We trust, however, to hear of his speedy and complete recovery.

The Lighting of the Temple.—Mr. Francis Teague, of Stanhope-street, Euston-road, writes us as follows:—"In your issue of the 10th I notice a slight error in your Note referring to the electric lighting at the Temple, viz., that the church had been fitted temporarily only. The church possesses a permanent installation, which was put in during December, 1886, and January, 1887. After several experiments had been tried in order to determine the most suitable arrangement for the lamps, they are placed so as to be as little conspicuous as possible; in fact, they are not noticeable when not burning, for throughout the edifice they are fixed so as to project slightly beyond the tops of the capitals of the columns supporting the magnificent vaulted roof. By this plan they in no way interfere with the general character of the architecture, which is a most desirable feature in installations of this order; and, I may add, that the installation has been in regular use since its completion. The contractors were Messrs. Mortimer, Shepherd and Co., of 2, Great Queen-street, W.C., but their existence as a firm ceased in August, 1887, when they dissolved partnership."

A Remarkable Exhibition of St. Elmo's Fire.—"A remarkable exhibition of St. Elmo's fire" (says a correspondent of the New York *Electrical Review*) "was recently witnessed by the writer on the summit of the Sonnblick mountain in Austria, about 10,000ft. above sea level. The synoptic weather chart for September 9 shows that there was at the time a ridge of high pressure over Central Europe, with light and variable winds at the low level stations. On the Sonnblick it had rained all day, with a south-west to a southerly gale. The pressure, which was high (nearly 20·7in., the normal being about 20·3in.), was falling irregularly, and the temperature was about 37deg. F. About 6 p.m., with a sudden shift of the wind to the north, the pressure rose and the temperature fell to 30deg. F., causing the rain to change to sleet and snow. About this time brushes of violet light were noticed outside the observatory upon the points of the lightning rod, the anemometer cups, and even upon projecting pieces of rock. From the heads of the observers and from their outstretched hands similar brushes of light streamed (resembling the positive discharge from an electric machine), accompanied by a cracking noise and a pricking sensation. This continued until the wind, which meantime had fallen to a calm, changed its direction to south-west and the pressure became stationary. The temperature soon rose above the freezing point, but the snow continued to fall for some hours."

The German Government and the Telegraphs.—The Berlin correspondent of *The Times* states that the German Reichstag has read twice the Bill for confirming the agreement for the purchase by the Government of the cables of the German Union Telegraph Company, and the third reading may be expected very shortly. By this measure the Imperial Post Office will from the 1st January, 1889, or the 1st of July, 1888, if it so desire, have possession of a four-wire cable from Emden to Lowestoft, and a cable from Greetsiel to Valentia (Ireland) now being used for German-American telegrams in connection at Valentia with the Anglo-American cables. The company was established in Berlin in 1871, but the capital, which was found in England, is now held chiefly by the Globe Telegraph Company and the German Union Telegraph and Trust Company, of London. The total capital of the company is 6,600,000m., and the purchase money to be paid by the Government is 6,300,000m.; but the company retains its reserve fund. This seems a good bargain for the German Government; but in view of its determination to work the telegraphic service between the two countries and materially to reduce the tariff, it was seen to be impossible to refuse the terms proposed by Dr. von Stephan. The Government takes over the agreements with the Anglo-American Company for the working of the American traffic Sir James Anderson is now in Berlin.

Chess by Telephone.—A match took place at Stirling on Saturday between the Glasgow Chess Club and the Counties of Perth and Forfar. One of the players being unable to leave Dundee this game was played by telephone. A correspondent gives the following details:—The National Telephone Company, Limited, fitted up the necessary wires and apparatus to the Douglas Hotel from their Stirling Exchange, and placed the trunk wire between Dundee and Stirling at the disposal of the players. Mr. Sandeman arranged to play in a residence in the west end of Dundee already connected to the Dundee Exchange. The local instruments were connected to each end of the trunk wire between the two towns, and thus the players were put in direct telephonic communication. The game was a very close one, and concluded, on time being announced at 6:30 p.m., by Mr. Sandeman resigning. The distance spoken over *viâ* the cable under the Tay and through Fifeshire was nearly 72 miles, but the announcement of the moves was as clear as if the speakers had been in the same town. At the conclusion of the match Stirling telephoned the victory of the Counties to Dundee, the Counties having 15½ games to 14½ for Glasgow. Messages were then telephoned to and from Mr. Sandeman and various friends at Stirling. The game by telephone was conducted most satisfactorily, and opens up a new departure in facilitating the playing of games and matches with friends or clubs at a distance. Mr. John D. Miller, the district manager for the company, and others interested in the game were present.

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NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

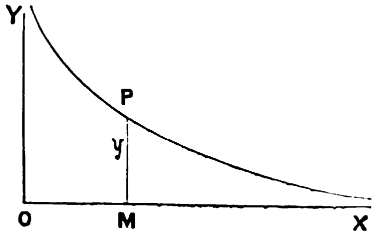
(Continued from page 316.)

A curve such that the rate of growth or shrinkage of the ordinate is proportional to the ordinate itself is called a logarithmic curve.

Let a curve (Fig. 20) be described by the extremity P of an ordinate, P M, which moves uniformly along O X, parallel to itself, and let P M *shrink* in height at a rate proportional to its height at any instant. Then the equation to such a curve is

$$y = -A\frac{dy}{dt},$$

and since e^{-Bx} (where e = the base of Naperian logarithms $= 2{\cdot}71828$) is a function which fulfils this condition of having



a differential coefficient proportional to itself, we can write the solution of the above

$$y = e^{-\frac{t}{A}},$$

for it is at once seen that by differentiating the equation

$$y = e^{-\frac{t}{A}}$$

we obtain $$\frac{dy}{dt} = -\frac{e^{-\frac{t}{A}}}{A};$$

and therefore $$y = -A\frac{dy}{dt}.$$

Returning to our equation for the current we can write as an equivalent for the equation

$$I - i = T\frac{di}{dt}$$

the equation $$I - i = -T\frac{d(I-i)}{dt},$$

or $$\frac{dt}{T} = -\frac{d(I-i)}{I-i};$$

intergrating this we have as a solution

$$-\frac{t}{T} = .\log(I-i) + \text{const.}$$

The constant has to be determined by the condition that when $t = 0$ $i = 0$, which gives const. $= -\log$ I. Hence the complete solution is

$$-\frac{t}{T} = \log(I-i) - \log I,$$

or $$I - i = Ie^{-\frac{t}{T}}.$$

This last equation expresses the fact that the amount by which the current falls short of its full value I, at any time t, after applying the E.M.F., is a fraction of its full value, equal to $e^{-\frac{t}{T}}$. When $t = 0$, or at the instant of closing circuit $I - i = I$, or the current $i = 0$, when $t = T$, $I - i = \frac{I}{e}$, or the deficit from full current is equal to $\frac{1}{2{\cdot}718}$ × the maximum current. Hence we may define the *time constant* of a circuit as the time reckoned from the instant of closing the circuit in which the current rises up to a value equal to $\frac{e-1}{e}$ of its full value, or to about ·632 of its maximum value. Approximately we may define the time constant as the time from closing the circuit in which the current rises up to ⅔rds of its maximum value $\frac{E}{R}$.

The rise of current strength in a wire of inductance L and resistance R when a steady external electromotive force, E, is applied to the circuit can be represented by a current curve, as shown in Fig. 21.

Let O X (Fig. 21) be a time line on which we mark off time as lengths reckoned from O. Let lines drawn vertically to this represent the current strength at any instant in a circuit of time constant T, inductance L, and resistance R, and let $OY = I = \frac{E}{R}$ represent the maximum current which is finally found in the circuit. On applying the electromotive force E to the circuit, the current strength grows up in the wire as graphically represented by the curve, the law of growth being that the rate of growth at any instant, multiplied by the time constant, is equal to the difference between the actual current at that instant and the maximum current strength finally attained, or symbolically

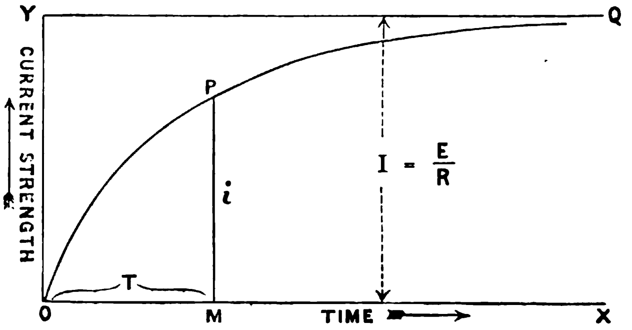
$$I - i = T\frac{di}{dt},$$

the solution of the differential equation being

$$I - i = Ie^{-\frac{t}{T}}$$

or $$i = I\left(1 - e^{-\frac{t}{T}}\right)$$

This last equation gives us the value of the current strength at any time t seconds after closing the circuit in terms of the time constant and the maximum current I which is finally attained.



The maximum current I would be produced at once in the circuit if its inductance were zero, so that we may finally formulate the law of growth of current in a circuit of inductance L, resistance R, and no sensible capacity, by saying that *the current strength at any instant added to the rate of growth of the current strength at that instant multiplied by the time constant, is equal to the current which would exist in the circuit if inductance were zero.*

The application of this principle to the case of simple periodic currents will lead to another proposition. Let there be a circuit which has an inductance L and resistance R, and let a simple periodic electromotive force act upon it. Let the maximum value of this E.M.F. be E, and let p stand for $2\pi n$ when n is the frequency of the oscillations, or $n = \frac{1}{T}$ when T is the duration of one single complete period; p is a quantity of the nature of an angular velocity, and may be called the *pulsation*. Then if t is the time which has elapsed from the commencement of the wave of E.M.F., and e is the actual value of the E.M.F. at that instant,

$$e = E\sin pt.$$

In this case the impressed electromotive force varies from instant to instant, passing from zero to a maximum, E, then to zero again, and then to a negative maximum − E. Accordingly our fundamental equation for the current strength at any instant is expressed thus,

$$\frac{d(Li)}{dt} + Ri = e = E\sin pt.$$

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For, the total rate of expenditure of work on the circuit at any instant when the current has a value i is $e\,i$, and this must be equal to the rate at which electrical work is being dissipated as heat, which is $R i^2$ by Joule's law, and the rate at which work is being stored up in the magnetic field, which is $\frac{d}{dt}(\frac{1}{2} L i^2)$;

hence, $$\frac{d}{dt}(\tfrac{1}{2} L i^2) + R i^2 = e\,i,$$

or, $$L \frac{di}{dt} + R i = E \sin p\,t.$$

In order to solve this differential equation and obtain the value of the current i in the circuit at any instant under the periodic electromotive force, we may adopt a well-known algebraic device, and substitute for the value of $\sin p t$ its equivalent in exponential terms. It is shown in treatises on trigonometry that

$$\sin \theta = \frac{e^{k\theta} - e^{-k\theta}}{2k},$$

where $k = \sqrt{-1}$, and e is the number 2·71828, which is the base of the Naperian logarithms.

Also $$\cos \theta = \frac{e^{k\theta} + e^{-k\theta}}{2};$$

hence $\cos \theta + k \sin \theta = e^{k\theta}$.

These are called the exponential values of the sine and cosine.

Taking the equation

$$L \frac{di}{dt} + R i = E \sin p\,t,$$

we divide both sides by L and writing T as before for the *time constant* $\frac{L}{R}$, we get

$$\frac{di}{dt} + \frac{i}{T} = \frac{E}{RT} \sin p\,t.$$

Multiply both sides by $e^{\frac{t}{T}}$ (e being the exponential base, not impressed E.M.F.), and we have

$$\frac{di}{dt} \cdot e^{\frac{t}{T}} + \frac{i}{T} e^{\frac{t}{T}} = \frac{E}{RT} e^{\frac{t}{T}} \sin p\,t.$$

The left hand side of this equation is the complete differential of $i e^{\frac{t}{T}}$, and may be written $\frac{d}{dt}\left(i e^{\frac{t}{T}}\right)$, and on substituting the exponential value for $\sin p\,t$ and putting k for $\sqrt{-1}$, we have

$$\frac{d}{dt}\left(i e^{\frac{t}{T}}\right) = \frac{E}{2kRT}\left\{ e^{\left(\frac{t}{T} + kpt\right)} - e^{\left(\frac{t}{T} - kpt\right)} \right\}$$

The right hand side of this last equation is the complete integral of

$$\frac{E}{2kRT}\left\{ \frac{e^{\left(\frac{1+kpT}{T}\right)t}}{\frac{1+kpT}{T}} - \frac{e^{\left(\frac{-kpT}{T}\right)t}}{\frac{1-kpT}{T}} \right\}$$

which becomes by simplification

$$\frac{E}{2kR} e^{\frac{t}{T}} \left\{ \frac{e^{kpt}}{1+kpT} - \frac{e^{-kpt}}{1-kpT} \right\}$$

hence equating both sides when integrated we have

$$i = \frac{E}{2Rk}\left\{ \frac{e^{kpt}}{1+kpT} - \frac{e^{-kpt}}{1-kpT} \right\}$$

Substituting back into sine and cosine terms, and recollecting that

$$e^{kpt} = \cos p\,t + k \sin p\,t,$$

and $$e^{-kpt} = \cos p\,t - k \sin p\,t,$$

we get finally

$$i = \frac{E}{R}\left\{ \frac{\sin p\,t - p\,T \cos p\,t}{1 + p^2 T^2} \right\}$$

If $p = 0$—that is, if the pulse is infinitely long, or the electromotive force continuous—then we have simply $i = \frac{E}{R}$, which is Ohm's law; but when p is not zero, and we have periodic variation of E.M.F., we see that the current value is not obtained by dividing E by R, but by multiplying this quotent by a factor. We can, however, put the above equation in a more intelligible form. Replace T by $\frac{L}{R}$, and let θ be an angle whose tangent is $\frac{Lp}{R}$;

hence $$\tan \theta = \frac{Lp}{R} = p\,T.$$

It follows by an easy transformation that

$$\cos \theta = \frac{R}{\sqrt{R^2 + p^2 L^2}}, \text{ and } \sin \theta = \frac{Lp}{\sqrt{R^2 + p^2 L^2}}.$$

We have then for the value of the current

$$i = \frac{E}{R}\left\{ \frac{\sin p\,t - p\,T \cos p\,t}{1 + p^2 T^2} \right\}$$

or, by substitution,

$$i = \frac{E}{\sqrt{R^2 + p^2 L^2}}\left\{ \sin p\,t \cos \theta - \sin \theta \cos p\,t \right\}$$

$$\therefore i = \frac{E}{\sqrt{R^2 + p^2 L^2}} \sin (p\,t - \theta).$$

This is the final solution of the equation

$$L \frac{di}{dt} + R i = E \sin p\,t = e,$$

and it shows us three things. First, that the phase of the current i is retarded behind that of the impressed electromotive force by an angle θ—such that $\tan \theta = p\,T = \frac{Lp}{R}$; and second, that the maximum value of the current is obtained by dividing the maximum value of the electromotive force by a quantity equal to $\sqrt{R^2 + p^2 L^2}$; and third, that the current curve is a simple periodic curve. The quantity $\sqrt{R^2 + p^2 L^2}$ is called the impedance of the circuit.

We have seen from the explanations on previous pages that the average or true mean value of a simple periodic quantity is equal to its maximum value multiplied by $\frac{2}{\pi}$. Hence, if we write Im for Impedance, we can put the equation, giving the value of the current produced by a simple periodic impressed electromotive force of maximum value E, operating on a circuit of resistance R, inductance L, with a pulsation p, in the form

$$i = \frac{E}{Im} \sin (p\,t - \theta),$$

and in words

	average current strength	=	*average impressed electromotive force* / *impedance*
and	maximum current strength	=	*maximum impressed electromotive force* / *impedance*

We see, then, that in the case of simple periodic electromotive force the quantity called the impedance appears to be related to the impressed E.M.F., just as does the resistance to the steady E.M.F. in the case of continuous currents, and the above may be called the equivalent of Ohm's law for alternate currents. Compare as below

For steady or continuous currents	current strength	=	*electromotive force* / *resistance*	(Ohm's law).
For simple periodic or alternate currents	average current strength	=	*average impressed electromotive force* / *impedance*.	

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Instead of *average*, we may write in the above *maximum*, or *square root of mean square* of the current.

Impedance is a quantity which is measured like resistance, in ohms, and has for that reason been sometimes called the *virtual resistance.*

(*To be continued.*)

EXPERIMENTS ON THE CONDITIONS WHICH DETERMINE THE STABILITY OF A TELEGRAPH WIRE.

BY FRANK CAWS.

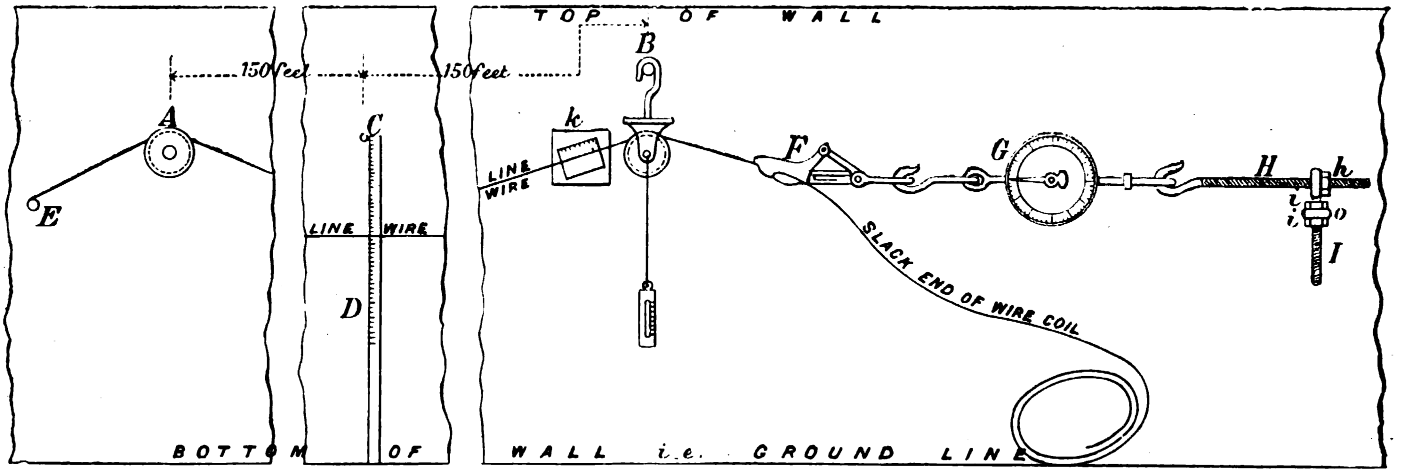
Part II.

While believing that engineers will find the diagram* given last week and other diagrams framed on a similar graphic system very handy for reference, I also append a table showing in figures the experimental dips under column E, dips given by the 14,500,000lb. modulus under column C, dips given by the 17,000,000lb. modulus under column C_1, and dips given by Mr. Preece's table under column P, likewise experimental stresses under column *e*, stresses given by the 14,500,000lb. modulus under column *c*, stresses given by the 17,000,000lb. modulus under column c_1, and stresses given by Mr. Preece's table under column *p*. And I add, with view to make the table complete for the use of students, experimental catenary lengths, and (which are practically the same) catenary lengths calculated by the 17,000,000lb. modulus under column L, catenary lengths due to 14,500,000lb. modulus under column *l*, and catenary lengths due to Mr. Preece's dips and stresses of inelastic wire under column marked (*). And to this I have added two columns for stretch, viz, column S for stretch as per 17,000,000lb. modulus, which corresponds very nearly with experimental results; and column *s* for stretch as per 14,500,000lb. modulus. Also I give for normal length of unstretched wire a column, marked N, for 17,000,000lb. modulus (agreeing very nearly with experiment); and another column, *n*, for the 14,500,000lb. modulus; and still another column, *o*, which results, of necessity, from Mr. Preece's table. All these particulars are, of course, not needed by the practitioner so much as by the student who desires to understand "the conditions that determine the stability of a telegraph wire." The practitioner will find all he needs under columns E and *e*, and likewise per lines E and *e* of the diagram.

The difference between the experimental stress, 81·75lb., and the calculated stress, 82·5lb., is traceable to the difference between the catenary and parabola. In point of fact, the real difference due to neglect of catenary must have been about $\frac{0·78}{82·5}$ instead of $\frac{0·75}{82·5}$, for at the conclusion of the experiments I cut the wire exactly at the two points of support; and, weighing it, discovered that instead of weighing 5·68lb. (the weight due to a 100lb. per mile wire) it actually weighed 5·9lb. The experiments on which the above table is based were repeated on two occasions with the same results. The copper wire was on these two occasions of the same quality as the Government wires, and was quite new. I also tried the same experiments with a copper wire which had been about a year and a-half in use on a telephone company's span in this district, and which (after the experiment) was cut and weighed, making 5·85lb. The differences between corresponding dips and stresses of new and old wires proved to be as follow: — *new*, dip 2·98ft., stress 70·33lb.; *old*, dip 2·96ft., stress 70·25lb.; *new*, dip 3·345ft., stress 63·25lb.; *old*, dip 3·36ft., stress 61·75lb.; *new*, dip 3·895ft., stress 57lb.; *old*, dip 3·79ft., stress 54·75lb. There was one spliced joint in the old wire catenary; but the new wire catenary was in one length without joint. Between each of the dips named the catenary was paid out 0·054ft., as hereinafter described.

It now remains for me, in conclusion, to explain in detail how the experiments were conducted.

I obtained permission to use a very long and perfectly straight wall near the railway station at Monkwearmouth;



and on this wall I marked, with the utmost accuracy, the two points of support of a 100-yard span, and an intermediate point at midspan, all three points on one level. After I had had steel pins fixed in the wall at the required levels and distances, I carefully remeasured the distances and verified the levels by means of my surveyor's level-staff and "dumpy." The following description refers to the diagram:—A is a steel pin driven into the wall, having threaded upon it a porcelain shackle bell. B is a steel pin driven into the wall, exactly 300ft. distant from A. C is a steel pin driven into the wall exactly midway between A and B. A plated pulley with grooved edge is suspended from B, and attached thereto is a thermometer suspended as a plummet. The top edge of this pulley is exactly level with the top of the pin C and with the top bed of groove of bell A. So, when the line-wire is suspended over pulley at B and bell A, the exact dip of the catenary can be measured down from C by the vertical rule D, which, being graduated in decimal parts of a foot, gives at once the figures in column E, per above table. At E (diagram) the line wire is securely fastened round a pin driven into the wall. At the opposite end of the span the line-wire is securely held by the linesman's vice, F, which is hooked on to the Salter's spring balance G; which, in turn, is hooked on to H, which is a screw-threaded bolt about 14in. long, threaded through an eye at the top end of the vertical bolt J, and having an adjusting nut, *h*, against the said eye of vertical bolt. The vertical bolt J is dropped through an eye formed

* In Part I., the diagram marked 5 should have been marked 6, and diagram marked 6 should have been marked 5.

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TABLE OF DIPS, STRESSES, EXPANSION AND STRETCH OF A 100 YARDS SPAN OF 100LB. COPPER WIRE AT VARYING TEMPERATURES.

Temp. Fah.	DIP.				STRESS.				CATENARY LENGTH.			Normal length of wire unstretched.			Stretch.		Expansion reckoned from 22° F. as datum.
	E	C	C_1	P	*e*	*c*	c_1	*p*	L	*l*	*	N	*n*	*o*	S	*s*	
deg.	ft.	ft.	ft.	ft. in.	lb.	lb.	lb.	lb.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.
22	2·5842	2·5842	2·5842	2 8	81·75	82·5	82·5	80	300·05936	300·05936	300·05936	299·76436	299·7134	300·05936	·29500	·3459	nil, datum
40	2·980	2·9047	2·9455	3 7	70·33	73·4102	72·3884	59	300·07721	300·075	300·11336	299·81836	299·7674	300·11336	·25885	·3076	·054
58	3·345	3·2692	3·3517	4 3⅝	63·25	65·4219	63·6356	49	300·09986	300·0953	300·16736	299·87236	299·8214	300·16736	·22750	·2739	·108
76	3·695	3·6635	3·7912	4 11½	57·00	58·2309	56·2742	43	300·12776	300·1193	300·22136	299·92636	299·8754	300·22136	·20140	·2439	·162

on the outer end of a strong spike, *o*, driven into the wall; and, as J is screw-threaded and fitted with the two adjusting nuts *i i* above and below *o*, it is easy by using the nuts *i i* to raise or lower H to any exact height, so that the angle of the line-wire may be equal on both sides of pulley B, which is evidenced by the (thermometer) plummet hanging in the same vertical line with pulley axle and nail-head B. A piece of board, *k*, is nailed to the wall close to the pulley B; and to this board is affixed a card, carefully graduated along its upper edge into divisions of 0·003ft., each of which divisions is the measure of expansion the 300ft. span of copper wire will undergo for each degree F. Upon the line-wire, close to this card, a small, light, delicate pointer is fixed. Then, by working the screw nut *h*, the line-wire can be slacked or tightened, and the little pointer moving along the graduated edge of the card indicates with extreme nicety the measure of extension or contraction which the catenary arc has undergone. Throughout the experiments the thermometer was continually observed. On the occasion of the first experiments the thermometer varied from 49 to 50½deg. F., and allowance was carefully made (by means of the card) for this variation. But on the occasion of the second and last experiments the thermometer stood steadily at 40deg. F. throughout the whole time.

I took the Salter's spring balance G (which was a perfectly new one) to the Weights and Measures Office, Sunderland, and had it most carefully tested by the officials, and proved it quite correct before experimenting with it. On the first occasion there was no wind at all, and on the second occasion, thanks to the sheltering wall, the light breeze which was blowing did not interfere with our results. On both occasions I had the valued assistance of the engineer of one of our largest telephone companies, as well as of several members of his staff, and of my own pupils. A careful study of my apparatus, as above sketched and described, will convince the student that all possible error from friction was eliminated. The effect of expansion on dip and stress was produced and proved by first setting the line wire to datum dip of 2·5842ft., and then setting the pointer on line-wire to zero on the graduated card. Then, by means of screw nut *h*, slacking off, so as to let the pointer travel 0·054ft. along the card, we obtained the dip due to an increase of 18 deg. F. It is true that when the length of the catenary is expanded by actual heat no addition is made to the weight of wire in the span. And it is true that, by the experimental equivalent for expansion, the weight of barely ⅝in. length of wire (per 18 deg.) is added to the span; but that addition has no measurable consequence or effect. For all practical purposes the equivalent for expansion adopted throughout these experiments is a true equivalent, giving the same dips and stresses as the actual expansion would give. Thus, it will be understood that starting from a dip of 2 5842ft. (due to 22deg. F. at quarter breaking strength of wire) and adding, at each experiment, 0·054ft. to catenary, we obtained successively the dips and stresses due to 40, 58, and 76deg. F., as per table and diagrams. And working near the ground, with all the apparatus close to the eye, we were able to make the most minute observations without difficulty.

The moral of these experiments clearly is, that *the saving virtue of the line-wire is its elasticity*, and that a considerable increase of virtual elasticity, by means of spring shackles, or some such device, would be equivalent to a correspondingly considerable increase in the life of the line.

Mr. Preece has ignored Elasticity in his published table of dips and stresses; and has, in his speeches and correspondence, treated it as of no practical consequence. Yet Elasticity is the best friend Mr. Preece possesses in this connection. The wires which are erected in the summer at 43lb. tension, thanks to the kind offices of Elasticity, reach a winter stress of only 59lb., instead of the 80lb. assigned by Mr. Preece's table. And so it comes about that snowstorms and other exceptional stresses do *not* invariably wreck the lines, as they surely *would* if Elasticity were not a much more powerful friend of Mr. Preece's than he deems it. The partial salvation of the lines is now undoubtedly due to the limited extent of elasticity possessed by the wires themselves. Let this extent be sufficiently enlarged by the spring shackles, or other equivalent means, and the salvation, which is now partial, will be complete.

That the trouble of overhead wires as at present hung is *real* (and not "imaginary," as it has been called) is demonstrated, practically, by the enormous and, I believe, quite unnecessary outlay incurred by our Government in changing town wires from overhead to underground; and is still further demonstrated by the Bill now coming before Parliament, by which the telephone companies seek increased power of obtaining wayleaves over housetops. And outside of towns the proof that a real trouble is experienced, from the inability of the wires to save themselves by their own unaided elasticity, is afforded by the increasing tendency of modern telegraph engineers to shorten their spans. I do not know what the Post Office engineers are doing just now in this respect; but I do know that the telephone companies' engineers are reducing their spans greatly wherever practicable, and that the American telegraph engineers are doing so to a still greater extent. The forces of Nature must prevail; and, since it is coming to be a battle between multiplying posts or applying springs, we have, in the immediate future, another illustration awaiting us of "the survival of the fittest."

It is to the interest of the public service that the invaluable character of Elasticity, as the saviour of the telegraph wires, should be fully realised; and that rational proposals (such as those made by Sir Frederick Bramwell at the Manchester meeting of the British Association) for incorporating an additional quantity of this saving element should be *rationally tested* by the authorities who are responsible to the public for good inventions rejected, no less than for bad ones accepted. The subject is one on which a jury of engineers rather than of electricians should decide; as electricians are no more renowned for their proficiency in mechanics than are engineers credited with a knowledge of electrical science.

Telephone Manufacture.—The ss. "Gothenburg City" arrived at Antwerp on the 8th inst. from Newport News, Virginia, with 1,270 tons of walnut logs, consigned to the Bell Telephone Manufacturing Company. This cargo of walnut, which is one of the largest ever brought to Europe, comprising no less than 1,828 logs, will be used entirely in the manufacture of telephonic apparatus.

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FORMULÆ FOR CONVERTERS.*

BY PROFESSOR GEORGE FORBES, F.R.S. (L. AND E.)

The modern transformer for electric lighting is an induction apparatus in which the primary coil is of high, and the secondary of low, resistance, consisting of two ring coils of insulated copper wire enclosed in an iron sheathing, so subdivided as to prevent the formation of local currents in the iron when subjected to the influence of alternating electric currents in the coils. The terminals of the primary are kept at a constant mean difference of potential. The secondary circuit includes the lamp circuit, and is of varying resistance. The iron is so situated with respect to the coils that there is no free magnetism; this simplifies the mathematical treatment of the phenomena.

It is required to predict (1) the magnetic induction in the iron, (2) the work given off to the lamp circuit, (3) the whole work absorbed by the apparatus, (4) the waste of energy when no lamps are in circuit, and (5) the effect which will ensue from varying the construction of the apparatus. The first of these has been approximately solved on the assumption that the permeability of the iron is constant.†

It is generally assumed that in such a system of electrical distribution the electromotive forces, the electric currents, and the magnetic induction are simple harmonic functions of the time. This would not be the case if the phenomenon called by Ewing "magnetic hysteresis" is taken into account, and in a preliminary investigation this must be omitted. Its effect in practice is insignificant so long as the magnetic induction in the iron is not high.

The notation now adopted is as follows :—

p_1 = number of turns in the primary coil.
p_2 = " " " secondary coil.
r_1 = resistance of the primary coil.
r_2 = " " secondary circuit, including lamps.
c_1 = current in the primary circuit.
c_2 = " " secondary circuit.
m = integral of the induction over the cross-sectional area of the iron.
$\rho = \dfrac{\text{mean length of lines of induction in the iron}}{\text{cross-sectional area of iron} \times \text{permeability}}$.
n = π × number of alternations of E.M.F. per second;
= 2π × " " complete periods of E.M.F. per second.
w_1 = work done in unit time by the primary current.
w_2 = " " " in the secondary circuit.
e = difference of potential of primary terminals.

C.G.S. units are adopted throughout.

Assume
$$m = \mathrm{M} \sin n t \quad . \; . \; . \; . \; . \; . \quad (1)$$
then
$$c_2 = -\frac{p_2}{r_2}\frac{dm}{dt} = -\mathrm{M}\, n \frac{p_2}{r_2} \cos n t \quad . \; . \; . \; . \quad (2)$$
and
$$w_2 = \int_0^1 c_2^2 r_2\, dt = \frac{\mathrm{M}^2 n^2 p_2^2}{r_2}\int_0^1 \cos^2 n t = \frac{\mathrm{M}^2 n^2 p_2^2}{2 r_2}\int_0^1 (1 - \cos 2 n t)\, dt.$$
The mean value of the periodical part is zero. Hence
$$w_2 = \frac{\mathrm{M}^2 n^2 p_2^2}{2 r_2} \quad . \; . \; . \; . \; . \; . \; . \quad (3)$$

Again,
$$\mathrm{M} \sin n t = \frac{4\pi}{\rho}(p_1 c_1 + p_2 c_2);$$
whence
$$c_1 = \frac{\mathrm{M}\rho}{4\pi p_1}\sin n t + \frac{p_2^2 n \mathrm{M}}{p_1 r_2}\cos n t \quad . \; . \; . \quad (4)$$
$$= \mathrm{C}_1 \sin (n t + a),$$
if
$$\mathrm{C}_1 \cos a = \frac{\mathrm{M}\rho}{4\pi p_1} \text{ and } \mathrm{C}_1 \sin a = \frac{\mathrm{M} p_2^2 n}{p_1 r_2}.$$
Again,
$$c_1 = \frac{\mathrm{E}}{r_1}\sin (n t + \beta) - \frac{p_1}{r_1}\frac{dm}{dt}; \text{ if } e = \mathrm{E} \sin (n t + \beta),$$
$$= \frac{\mathrm{E}}{r_1}\cos\beta \sin n t + \left(\frac{\mathrm{E}}{r_1}\sin\beta - \frac{p_1 \mathrm{M} n}{r_1}\right)\cos n t. \quad (5)$$

Equating coefficients in (4) and (5), we have
$$\mathrm{E}\cos\beta = \frac{\mathrm{M}\rho r_1}{4\pi p_1}; \quad \mathrm{E}\sin\beta = \mathrm{M}\, n\left(p_1 + \frac{p_2^2 r_1}{p_1 r_2}\right)$$
$$= \mathrm{M}\, n\, p_1\left(1 + \frac{p_2^2 r_1}{p_1^2 r_2}\right);$$
whence
$$\frac{\mathrm{E}^2}{\mathrm{M}^2} = \left(\frac{\rho r_1}{4\pi p_1}\right)^2 + n^2 p_1^2\left(1 + \frac{p_2^2 r_1}{p_1^2 r_2}\right)^2 \quad . \; . \quad (6)$$
also,
$$w_1 = \int_0^1 c_1 e\, dt = \mathrm{C}_1 \mathrm{E}\int_0^1 \sin (n t + a) . \sin (n t + \beta) . dt$$
$$= \frac{\mathrm{C}_1 \mathrm{E}}{2}\int_0^1 \{\cos (a - \beta) - \cos (2 n t + \beta + a)\}\, dt$$
$$= \frac{\mathrm{C}_1 \mathrm{E}}{2}\cos (a - \beta) = \frac{\mathrm{C}_1 \mathrm{E}}{2}(\cos a \cos\beta + \sin a \sin\beta)$$
$$= \frac{\mathrm{M}^2}{2}\left\{ r_1\left(\frac{\rho}{4\pi p_1}\right)^2 + \frac{n^2 p_2^2}{r_2}\left(1 + \frac{p_2^2 r_1}{p_1^2 r_2}\right)\right\} \quad . \; . \; . \quad (7)$$
$$= \frac{\mathrm{E}^2}{2} . \frac{r_1\left(\frac{\rho}{4\pi p_1}\right)^2 + \frac{n^2 p_2^2}{r_2}\left(1 + \frac{p_2^2 r_1}{p_1^2 r_2}\right)}{\left(\frac{\rho r_1}{4\pi p_1}\right)^2 + n^2 p_1^2\left(1 + \frac{p_2^2 r_1}{p_1^2 r_2}\right)} \quad . \; . \; . \quad (8)$$

When the actual figures pertaining to a modern transformer are inserted, it is found that the quantity $\frac{p_2^2 r_1}{p_1^2 r_2}$ is less than ·01; that the first term of the numerator in (8) is small compared with the second; and that the first term of the denominator is very small compared with the second.

The efficiency is found by dividing (3) by (7).

When no lamps are used on the secondary circuit, the rate of work done is, by (7) (r_2 being infinite),
$$\text{waste} = \frac{\mathrm{M}^2}{2} r_1 \left(\frac{\rho}{4\pi p_1}\right)^2.$$

It will be noticed that the efficiency of the apparatus depends on the first term in (7) being small compared with the second; hence n (or the number of alternations per second) may be diminished without loss of efficiency if ρ be diminished, or if the mass of iron be increased.

* Paper read before the Society of Telegraph-Engineers and Electricians on the 9th February.

† J. Hopkinson, *Proc.* Roy. Soc., 1887.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER VIII.—*The Calibration of Current Indicators.*

(Continued from page 377.)

81. The relation between the angular deflections of a needle and the currents causing those deflections, in an indicator, is a most useful thing to be known about the instrument. The currents causing given deflections on any instrument may be directly proportional to those deflections, or they may vary as some known function of the angles of deflections, or there may be no settled relation between them at all. It is in the latter case that "calibration" is desirable, and the relation between the angular deflections and currents is generally shown by means of a curve, which can be referred to when it is required to know what is the strength of current corresponding to a given deflection. There are different methods of carrying out the calibration of an indicator, more or less suitable according to the resistance and sensibility of the instrument. We shall first take the simplest method, which can readily be applied to the calibration of high-resistance instruments when a few similar *low-resistance* cells are available. The internal resistance of a cell will be low when its plates are of large size and fixed near together. Almost any type of cell will do for this test, provided its plates are of large area, in addition to which the cells should not polarise; this latter difficulty, however, being very unlikely to occur, as the time of contact need only be very short to take a reading of the deflection, and the comparative high resistance of the instrument

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would allow very little current to pass from the cells. The Thomson tray cells (Fig. 47) previously described in these papers are of very low internal resistance, varying from $\frac{1}{10}$th to $\frac{1}{2}$ an ohm per cell, and would be very suitable; or if some charged accumulators were available these would do better still, their resistance being only about $\frac{1}{50}$th of an ohm per cell.

Taking, in the first instance, a vertical detector of high resistance compared to the cells, it would be first connected to one cell in the manner shown in Fig. 47; the deflection might then be large or small according to the weight of the needle. If the deflection is only a few degrees we should proceed, after noting it down, to connect up two cells, then three, and so on till the needle was deflected to near the end of the scale, say to 85 degrees, noting down opposite each number of cells the corresponding number of degrees deflection. Now the currents are very easily calculated, each cell having a fixed E.M.F., and its internal resistance so low in comparison to that of the instrument that it may be neglected. An example of this kind actually taken of a vertical detector of 220 ohms resistance is here appended. The cells used were secondaries, or accumulators measuring 0·02 ohm and 2 volts per cell, and the readings taken were as follows:—

No. of Cells.	Deflection.	Volts at Terminals of Instrument.
1	10	2
2	42	4
3	64	6
4	75	8
5	81	10
6	85	12
7	87	14

Now, it is desirable to obtain some intermediate readings between 10 and 42 degrees and below 10 degrees, as a very wide difference in the deflections is noticed between one and three

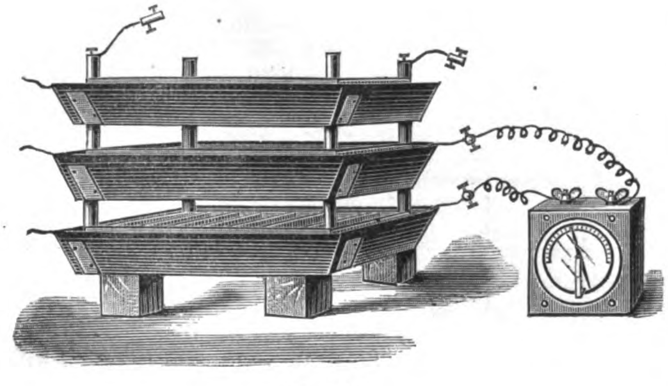


FIG. 47.

cells. We cannot get these intermediate readings by the cells alone, but must add a resistance to the detector to reduce the difference of potential at its terminals. First, it must be shown that the number of volts at the instrument terminals when connected direct to the cells is practically equal to the E.M.F. of the cells. By Ohm's law we have the current passing through the instrument is equal to the

$$\frac{\text{volts at instrument terminals}}{\text{resistance of instrument}}$$

and therefore the number of volts at the instrument terminals is always the product of the current and the instrument resistance. But the current is also, by Ohm's law, the

$$\frac{\text{total E.M.F. of battery}}{\text{total resistance in circuit}};$$

therefore, the number of volts at the instrument terminals is equal to the

$$\text{total E.M.F. of battery} \times \frac{\text{resistance of instrument}}{\text{total resistance in circuit}}$$

Now, if the instrument was connected directly to, say, 5 cells, the E.M.F. of battery would be $5 \times 2 = 10$ volts, and its resistance $0{\cdot}02 \times 5 = \frac{1}{10}$ ohm; and therefore the number of volts at the instrument terminals would be

$$10 \times \frac{220}{220\frac{1}{10}} = 10 \times \frac{2200}{2201},$$

where it is evident that the fraction by which the E.M.F. of 10 volts is multiplied is so nearly unity, that we practically have the same number of volts at the instrument terminals as we have E.M.F. in the battery. The reason is that the internal resistance of $\frac{1}{10}$th ohm is so small in comparison to 220 ohms, that it causes an inappreciably small loss of E.M.F. in the battery. This accounts for the third column given in volts. Now, to get the intermediate deflections in this case, extra resistances were added to the instrument, so as to produce respectively 1, $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ volts at the instrument terminals. By taking one cell, and adding a resistance equal to the instrument, the potential difference at the terminals became

$$2 \times \frac{220}{220 + 220 + {\cdot}02} = 2 \times \frac{1}{2} = 1 \text{ volt};$$

and by making the extra resistance equal to one-third that of the instrument ($= 73{\cdot}3$ ohms) the volts at the terminals became

$$2 \times \frac{220}{73{\cdot}3 + 220 + {\cdot}02} = 2 \times \frac{3}{4} = 1\tfrac{1}{2} \text{ volt}.$$

Similarly to obtain 3 volts, two cells were connected, and the extra resistance made the same as in the previous case. This gave

$$4 \times \frac{3}{4} = 3 \text{ volts}.$$

For $4\frac{1}{2}$ volts at the terminals, 3 cells were joined up, the added resistance being the same as before, which gave

$$6 \times \frac{3}{4} = 4\tfrac{1}{2} \text{ volts}.$$

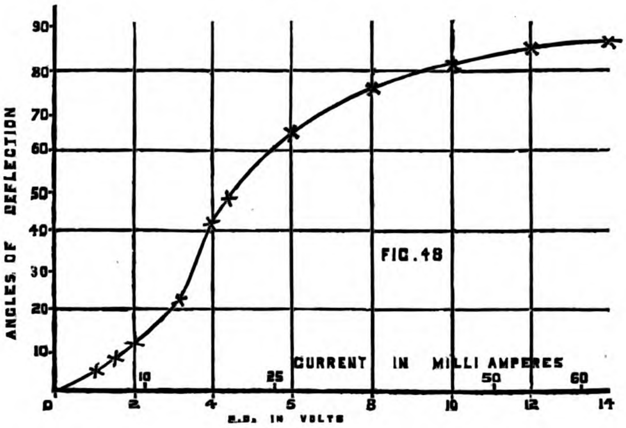


FIG. 48.

In any case it will be seen from the above that to obtain any given number of volts at the instrument terminals when low-resistance batteries are used as above, a resistance must be added equal to the resistance of the instrument multiplied by the following fraction—

$$\left(\frac{\text{E.M.F of battery}}{\text{number of volts required}} - 1\right)$$

The intermediate deflections observed with the above were then as follows:—

No. of cells.	Added resistance.	Deflection.	Volts at instrument terminals.
1	220	4	1
1	73	7	$1\frac{1}{2}$
2	73	22	3
3	73	48	$4\frac{1}{2}$

thus making eleven observations altogether, from which the curve in Fig. 48 is plotted. The angles of deflection are marked on the vertical ordinate, and the potential difference (P.D.) in volts at the terminals on the horizontal ordinate. The latter ordinate is also marked in units of current (milliamperes), the current in these units being simply the

$$\frac{\text{number of volts at terminals}}{\text{resistance of instrument}} \times 1000,$$

one milliampere being the $\frac{1}{1000}$th part of an ampere.

Now, since the denominator in the above is constant it is clear that the currents through the instrument are proportional to the volts at the terminals, and therefore the calibration curve connecting deflections with volts at the terminals is precisely the same as that connecting deflections and currents.

(To be continued.)

ELECTRIC TRACTION.

DIRECT CURRENT WORKING *versus* ACCUMULATORS.

BY MR. A. LINEFF.*

On the question of electrical transmission of power as applied to tramways, a rather vexatious problem presented itself. Should continuous conductors or accumulators be used? Electricians and non-professional people interested in tramways were divided into two distinct camps, theoretically hostile to each other. Unfortunately there were as yet no reliable data with reference to the life and cost of renewals of accumulators on tramways; but it was known that they were heavy. Yet sometimes even a rough estimation was of value for practical purposes, and he had recently prepared an estimate when giving his advice on a new tramway that was to be worked electrically.

He would compare the transmission of electrical energy:— A. By means of naked conductors suspended from telegraph-poles, which system would work well on tramways passing through open country. B. Underground conductors placed in a channel between the rails or on the side of the rails. C. Accumulators. As accumulators replaced only the conductor, he would leave out of the calculation all expenses relating to permanent way, generating plant, &c., and consider merely the cost of conductors as compared with the cost entailed by using accumulators. He would assume the line to be 1 mile long, with two cars for the accommodation of 46 passengers, running on it at an average speed of, say, 6 miles an hour. With the conductor system this could easily be accomplished with 30 amperes, at an actual pressure of 250 volts.

He took for conductor—

		£	£
A.	The cost per mile to be		200
B.	,, ,, ,, ... (which was a liberal allowance in each case; the figures had been taken from a *bonâ fide* tender.)		1,500
C.	When using accumulators 1½ ton of cells would be required per car; three sets, 4·5 tons, or two cars 9 tons, at £60	540	
	Increase in cost of cars, motors, &c., 50 per cent.	270	
	Total..................	—-	810

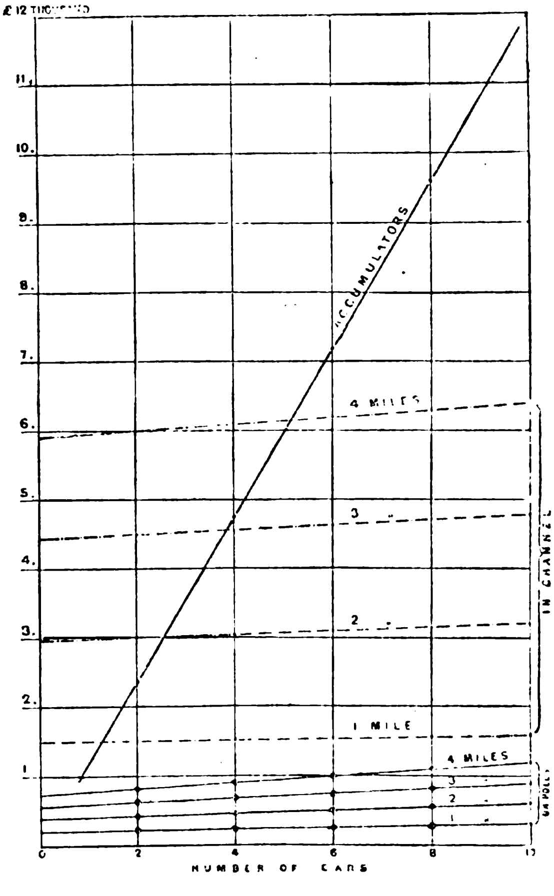
Say £800. Assuming interest and depreciation of conductors A and B at 10 per cent., and of accumulators at 30 per cent., which was rather in favour of the accumulators, the differences of depreciation in the two plants were 20 per cent. Now, in order to put both systems on the same footing as regarded depreciation, the actual cost of accumulators must be increased by the capitalised difference of depreciation of the two plants. Thus £1,000 invested in conductors would annually depreciate at the rate of £100; while, with accumulators, the loss would be £300, and would correspond to an outlay of £3,000 with a depreciation of 10 per cent. For this comparison, therefore, the actual cost of the accumulator plant must be trebled. It was clear that in case of an increased traffic, the capital outlay on the continuous conductor system would increase only nominally by the extra weight of copper to be added to the conductor. An allowance of £25 per mile for every two additional cars (30 amperes) would be ample. For accumulators the question was different; in this case, the cost of the accumulator plant must be multipled by the number of cars to be run. The following table was calculated for various lengths of line and various numbers of cars:—

COST OF CONDUCTOR AND ACCUMULATOR PLANT.

Length.	Two Cars.			Four Cars.			Six Cars.		
	A.	B.	C.	A.	B.	C.	A.	B.	C.
1 mile	200	1,500	2,400	225	1,525	4,800	250	1,550	7,200
2 miles..........	400	3,000	2,400	450	3,050	4,800	500	3,100	7,200
3 ,, ...	600	4,500	2,400	675	4,575	4,800	750	4,650	7,200
4 ,, ...	800	6,000	2,400	900	6,100	4,800	1,000	6,200	7,200

Length.	Eight Cars.			Ten Cars.		
	A.	B.	C.	A.	B.	C.
1 mile	275	1,575	9,600	300	1,600	12,000
2 miles	550	3,150	9,600	600	3,200	12,000
3 ,, ...	825	4,725	9,600	900	4,800	12,000
4 ,, ...	1,100	6,300	9,600	1,200	6,400	12,000

The values in this table had been used to prepare Fig. 9. The ordinates represented the cost, and the abscissæ the number of cars.



COMPARATIVE COST OF CONTINUOUS CONDUCTORS AND ACCUMULATORS.

FIG. 9.

The four thinner lines at the bottom of the diagram represented the cost of conductor placed on poles for 1, 2, 3, and 4 miles. The four dot-and-dash lines abave represented the cost of conductor in a slotted underground channel. The diagonal line across the diagram represented the cost of accumulators, and was independent of the length of the line, but was very much dependent on the number of cars running. This diagram showed:—(*a*) That wherever an aerial conductor could be used, the accumulator system could not compete with it, however small the traffic, if the length of the line did not exceed, say, 10 miles. (*b*) That for heavy traffic the accu-

* From the *Proceedings* of the Institution of Civil Engineers, being a speech delivered during the discussion on Dr. E. Hopkinson's paper on the Bessbrook and Newry Tramway

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mulator system could not compete even with the expensive underground continuous conductor. (*c*) That in each case, where an increase of traffic might be expected, the continuous conductor was preferable, as a trifling extra outlay in copper imparted great elasticity to the line with regard to the number of cars which could be worked on it. (*d*) That the accumulator system could be advantageously applied in towns on comparatively long lines with a small number of cars running, which was, of course, an exceptional case. Fig. 9 did not pretend to give with great accuracy the actual cost of individual systems; but it showed at a glance the characteristic features of each, and their relation to each other with regard to the capital outlay. The application of electric traction to railways was a question of great importance. It was an open secret that the Metropolitan underground lines were needing a radical change. Not only was the public choked with a vitiated air; but, what was more to the point, the shareholders began to suffer through the competition of the omnibus and tramway companies. The railway engineer might certainly point with pride to the fact that the consumption of fuel on those lines was under 30lb. per train-mile; but what was the amount of useful work done for it? Take as an instance the Metropolitan District Railway. The weight of the empty train was 92 tons; of the locomotive 47 tons; of a full load of passengers, 31 tons. The average number of passengers per train-mile was only twenty-seven, or about 1·5 ton; add 50 per cent. to arrive at the actual number, which would bring the useful load to 2·25 tons, and the ratio of $\frac{\text{paying load}}{\text{dead load}} = \frac{2 \cdot 25}{139}$, or only 1·6 per cent. Railway engineers could not be blamed; they did everything to make their power-producing machine as economical as thought, care, and great experience could make it. But the power was not suitable for the purpose. In order to reduce the cost of fuel and wages,* the railway engineer had only one way open to him: to increase the size of the locomotive, and therefore to run heavier trains. The consequences were:—Crammed trains for a few hours in the day, and almost empty ones during the remaining hours; slow service, immense waste of power, enormous wear and tear of the permanent way by locomotive wheels, with a weight of about 15 tons on each axle, and so on. The whole system seemed to be an illustration of what the French termed in logic *cercle vicieux*. With an electric plant, the aspect of working a railway would be entirely changed. The power would be generated at a central station or stations, and therefore under most economical conditions, with the least expenditure of fuel, attendance, and stores. The trains could be reduced to one or two carriages, starting in the busy hours of the day at intervals of one minute, or even less, and of four to five minutes during the remaining hours. In fact, the whole train service could be arranged to a nicety in accordance with the average requirements of the traffic. A separate heavy locomotive would be useless, as the motor could be fixed under the car or on the bogie; this alone would increase the efficiency, or the ratio of useful weight to dead weight, to at least five times its former value.† The work of driving and firing would be simply reduced to the turning of the switch in the guard's compartment, and therefore a great saving of wages would be at once effected. Moreover, it must be remembered that a dynamo or motor was kinemetrically one of the simplest mechanisms, having merely two journals with a rotating shaft and no reciprocating parts or motion of any sort. As a consequence, the cost of repairs of an electrical plant must be much less than with locomotive power. He thought it was quite time for the two great metropolitan railway companies to look into the matter more closely, and to give means to the electrical engineer to work out the problem. An investment like this would be of much greater benefit than the extension of existing lines on the old plan.

* Mr. J. S. Jeans has given in "Railway Problems," p. 146, the following table of expenditure incurred for locomotive power in 1885:—

	London and North-Western.	Great Western.
Wages	57·0	56·7
Fuel	35·2	34·2
Water	1·0	4·6
Oil, Stores	6·7	4·4
	99·9	99·9

† To refer to the above example for the Metropolitan District Railway, the introduction of electricity as motive power would alter the useful work thus:—A train of two empty carriages, 20 tons; motors, &c., gear, 2 tons; full paying load, ninety passengers, or 6·6 tons. The efficiency with full load would be $\frac{6 \cdot 5}{22} = 30$ per cent., half load $\frac{3 \cdot 3}{22} = 15$ per cent., quarter load $\frac{1 \cdot 65}{22} = 7 \cdot 5$ per cent., as compared with 1·6 per cent., the present ratio.

ON THE HEATING EFFECTS OF ELECTRIC CURRENTS.*

BY WILLIAM HENRY PREECE, F.R.S.

(Concluded from page 387.)

SERIES II.

The second series of experiments was made to determine the relative effect of the sudden application of powerful currents on wires of different materials such as would occur if in practice a short circuit suddenly took place. An electromotive force of 100 volts was used, and there being no appreciable resistance in the external circuit but the wire, the latter was subjected to the blow of a momentary current of immeasurable strength.

Metal.	Gauge.	Remarks.
	inches.	
Tin	0·0185	Fused with a sharp report, and scattered molten particles quite 6 feet in all directions.
„	0·136	Fuse diffused little more than a large splay of metal.
„	0·136 (repeated)	This wire was enclosed in a porcelain box, covered by a glass plate. It fused with considerable flame. The glass was broken into fragments, and the porcelain box chipped. Some fiery particles were thrown about.
„	0·064	One inch of wire was put into an earthenware box. When fused, the particles of metal were securely imprisoned by the box to which they adhered. All the lead was resolved into globules.
Platinum-silveralloy	0·061	Molten particles were shot a distance of 9 feet.
Platinum foil	0·001 thick	Molten particles thrown about 4 feet.
„	0·001 thick, 0·512 wide	„ „ „
„	0·00025 thick, ½in. wide	This strip of foil was 1¼in. long. Sparks thrown a few inches only.
Aluminium foil	0·001 thick	Molten particles scattered about 9 feet.
„	0·004 thick, ½in. wide	Incandescing particles thrown upwards and around, but not more than 3 feet distant.
„	0·001 thick ½in. wide	Profuse particles, and some thrown 6 feet distant in a white hot state.
Silver foil	0·001 thick, ¼in. wide.	Not so much splaying as in last experiment.
Pure silver wire	0·017	No incandescent particles reached the ground. The wire was destroyed with a sharp report.
Zinc foil	0·003 thick, ½in. wide	Better than silver foil, no particles being scattered.
„	0·003 thick, ½in. wide 2 strips.	A few particles were shot about 4 feet; one was of considerable size.
Copper wire	No. 20 B.W.G.	Large incandescent globules scattered around for a distance of 4 or 5 feet.
Brass wire	No. 18 B.W.G.	This went off with a flash, and threw to a short distance a splay of metal which remained incandescent for some moments, and burnt a hole in the table.
Hard-drawn bright steel wire	No. 18 B.W.G.	Scintillating particles flew in all directions to a great distance. This was the most dangerous break of all the experiments.
Mercury	....	Considerable flame produced, and particles widely scattered.

The conclusions derived from these experiments were that the best metal to use for small diameters was platinum, and for large wires tin. Platinum fuses in a wax-like kind of way, without explosion or scattering of molten particles. Platinum has great advantages over other materials; it neither tarnishes nor deteriorates. It is easily soldered.

Tin behaves very much in the same way when its dimensions are large. But it is very questionable whether large wires should ever be used for fusible cut-outs. Owing to radiation the surface keeps cool and solid, while the centre is molten and liquid. It bursts with an explosion, and the incandescent particles are forced away radially in all directions with considerable energy.

Fusible cut-outs are effective but somewhat barbarous, and from the absence of any scientific inquiry into their character and judgment in their use, they have in the majority of instances become rather a source of danger than of safety.

* Paper read before the Royal Society, Dec. 22nd, 1887.

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SERIES III.

The third series of experiments was made to determine the constant "a" when each wire was 6in. long, and therefore free from any cooling effect of the terminals.

COPPER.

Diameter in Inches.	Actual fusing current in amperes.	Fusing current calculated $ad^{3/2}$.	Constant "a"
0·004	3·253	2·956	12888
0·005	4·444	4·1:0	12569
0·007	7·618	6·842	13007
0·010	13·33	11·684	13330
0·013	15·55	17·32	10491
0·014	17·14	19·35	13835
0·018	25·55	28·22	10580
0·020	27·77	33·04	9818
0·023	35·55	40·75	10192
0·030	52·69	60·71	10140
		Mean =	11684

ALUMINIUM.

Diameter in inches.	Actual fusing current in amperes.	Fusing current calculated $ad^{3/2}$.	Constant "a."
0·004	3·322	2·011	13130
0·007	5·253	4·654	8970
0·010	10·20	7 948	10200
0·012	10·51	10·45	7996
0·014	16·19	13·17	9757·3
0·018	21·01	19·20	8700
0·020	23·48	22·48	8302
0·026	28·93	33·33	6900
0·030	87·08	41·30	7133
0·033	38·93	47·65	6493
0·036	43·80	54·30	6413
0·040	52·53	63·57	6568
		Mean =	7948·4

PLATINUM.

Diameter in inches.	Actual fusing current in amperes.	Fusing current calculated $ad^{3/2}$.	Constant "a"
0·004	1·723	..	6826·5
0·005	2·192	1·859	6200
0·007	3·211	3·080	5482·7
1·010	5·285	5·258	5285
0·012	6·734	6·910	5122·8
0·014	8·104	8·710	4884
0·018	11·28	12·700	4671
0·020	13·78	14·872	4872
0·027	22·55	23 330	5082·8
0·030	28·12	27·320	5411·8
0·033	32·75	31 520	5463·2
0 037	37·08	37·420	5209·9
0·040	43·26	42 063	5407·4
		Mean =	5258

GERMAN SILVER.

Diameter in inches.	Actual fusing current in amperes.	Fusing current calculated $ad^{3/2}$.	Constant "a"
0·004	1·825	1·317	7230·7
0·005	2 143	1·840	(031·3
0·010	5·554	5·204	5554
0·012	6·824	6·840	5191·2
0·014	9·125	8·620	5499·4
0·018	12·78	12·57	5292·2
0·020	14·40	14·72	5091·2
0·026	20·16	21·82	4808·8
0·030	27·14	27·04	5223·1
0·033	30·90	31·20	5150
0·037	36·15	37·03	5079
0·040	43·26	41·63	5407
		Mean =	5203·7

PLATINOID.

Diameter in inches.	Actual fusing current in amperes.	Fusing current calculated $ad^{3/2}$.	Constant "a."
0·007	3·(75	2·846	6275
0·010	5·285	4·860	5285
0·012	6·532	6·389	4969·1
0·014	8·036	8·050	4843·1
0·018	11·670	11·74	4832·6
0·020	14·21	13·75	5024
0 016	21·38	22·77	4563·2
0·028	28·436	29·13	4744
0·035	28·82	31·82	4401·3
0·040	40·67	38·88	5084
		Mean –	4860·7

IRON.

Diameter in inches.	Actual fusing current in amperes.	Fusing current calculated $ad^{3/2}$.	Constant "a."
0·007	2·10	1·869	3585·6
0·012	3·88	4·194	2951 7
0·014	5·277	5·285	3180 3
0·018	7·142	7·706	2957·4
0·620	8·888	9·076	3142·3
0·026	13·02	13·38	3105·7
0·030	15·71	16·58	3023·4
0·033	19·00	19·13	3169·0
0·036	21·90	21·80	3206·2
0·040	28·74	25·53	3592·5
		Mean =	3190·9

TIN.

Diameter in inches.	Actual fusing current in amperes.	Fusing current calculated $ad^{3/2}$.	Constant "a."
0·010	2·55	1·800	2550
0·014	3·244	2·983	1959
0·018	4·095	4·348	1696
0·020	4·675	5 093	1653
0·026	6·570	7·548	1567
0·030	8·656	9 356	1666
0·033	9 430	10 800	1573
0·036	11·60	12·30	1699
0·040	13·14	14·41	1643
		Mean –	1800·6

TIN-LEAD ALLOY (2 parts of Lead to 1 part of Tin).

Diameter in inches.	Actual fusing current in amperes.	Fusing current calculated $ad^{3/2}$.	Constant "a."
0·010	2·124	1·455	2124
0·0125	2·395	2·034	1714
0·014	2·472	2·411	1493
0·018	3·283	3·515	1359·5
0·020	3·515	4·117	1243
0 026	5·794	6·101	1882
0·030	6·990	7·562	1345
0·033	7·722	8·725	1289
0·036	8·961	9·941	1312
0·040	10 35	11·64	1294
		Mean =	1455·5

LEAD.

Diameter in inches.	Actual fusing current in amperes.	Fusing current calculated. $ad^{3/2}$.	Constant "a"
0·010	1·893	1·512	1893
0·012	2·202	1·988	1675
0·014	2·588	2·504	1565
0·018	3·824	3·652	1584
0·020	4·171	4·277	1475
0·026	6·025	6·339	1437
0·030	7·182	7·858	1382
	8·600	10·33	1259
	10·74	12·10	1342·5
		Mean =	1512·27

The value of the constant "a" for the different metals is therefore:—

	Inches.		Centimetres.
Copper	11684 0	....	2886·0
Aluminium	7948·4	....	1964·0
Platinum	5258·0	....	1299·0
German silver	5203 7	....	1285·0
Platinoid	4860·7	....	1201·0
Iron	3190·9	....	788·0
Tin	1800 6	....	445·0
Alloys (lead and tin, 2 to 1)	1455·5	....	359·5
Lead	1512 27	....	373·5

The values in the second column are obtained from those in the first by multiplying the latter by $\frac{1}{(2{\cdot}54)^{3/2}} = 0{\cdot}247$.

Since $C = ad^{3/2}$ gives the fusing current of any wire of a given diameter d, inversely—

$$d = \left(\frac{C}{a}\right)^{2/3}$$

will give the diameter of the wire which will fuse with a given current, C. Very useful tables can thus be calculated which would be of service to the electric light engineer.

[Jan. 5, 1888.—In all these experiments the results obtained on wires finer than those recorded—viz., those below 10 mils—were excluded, because it was found that they did not follow the law of the 3/2 power. In the discussion which followed the reading of the paper Prof. Ayrton pointed out that this must be so, and that it followed from Mr. Box's researches of 1868* that the current required to maintain a fine wire of a given material at a given definite excess of temperature is approximately directly proportional simply to the thickness of the wire. This has been fully developed in a paper read before the Society of Telegraph-Engineers and Electricians, November 24, 1887 (*Journal*, Vol. XVI, p. 539).]

CORRESPONDENCE.

THE TERM "MAGNETIC RESISTANCE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Though the notion of "magnetic resistance" may be in a way convenient in practical work, such as dynamo and transformer construction, I venture to differ with you with regard to the editorial note so far as to say that mathematical physicists will never adopt such a term.

The objection is that it is a false analogy. That Ohm's law does not hold in the case of iron is hardly the point. Ohm's law does not hold in the case of a conductor that heats; but that does not prevent our talking about the resistance of the conductor. People seem to have assumed that because there is a magnetising force and a resulting flux that the flux is a current. Electric potential produces a flux in an insulating medium, and this is called electro-static induction. Similarly, magnetic potential produces a flux, and this is called electro-magnetic induction. In the case of electric potential the induction depends on the inductive capacity of the medium. Similarly the magnetic induction depends on the magnetic inductive capacity or permeability. Iron is thus a magnetic insulator with an enormous coefficient of inductive capacity, and it is not analogous to a conductor.

Without being too critical I may call attention to the frequent improper use of German capitals. Maxwell used these to denote vectors, and they should not be used unless they are treated according to quaternion methods; or, at least, they should not be used indiscriminately for vector or scalar quantities. Thus M. Hospitalier's equation

$$\Phi = \frac{\mathfrak{F}}{\mathfrak{R}}$$

is from a strictly mathematical point of view nonsense. Of course this may be hypercritical; but M. Hospitalier lays himself open to criticism, to some extent, in adopting some of Maxwell's vector letters and misapplying others. Thus in the above equation Φ denotes the *flux de force*, or apparently the surface integral of the induction; $\mathfrak{F}$ denotes *la force magnétomotricé*, or the magnetic potential, Maxwell's Ω; and $\mathfrak{R}$ denotes *la résistance magnétique*, which appears to be μ multiplied by the area and divided by the length of the magnetic circuit.

Our grandfathers have told us that the Institute of Electrical

* "A Practical Treatise on Heat," 1868.

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Engineers appointed a nomenclature committee; but the result has been little so far, and it is difficult to know who are on it.—Yours, &c., JAS. SWINBURNE.

THE CUTTRISS SIPHON RECORDER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In *The Electrician* of January 20th, 1888, you publish a letter from William Dickenson, of Heart's Content, in which he insinuates that I have no claim to the invention of the siphon recorder described in your issue of November 11th, 1887; also that I claim priority for the employment of permanent magnets and a siphon vibrator.

No such claims as the two latter ones can be found in the article mentioned, and I would certainly be the last person to make them, inasmuch as I worked on the construction of a recorder twenty years ago (in Sir W. Thomson's laboratory), in which permanent magnets were used to produce the magnetic-field. The first practical application of a siphon vibrator undoubtedly belongs to Mr. Pescod, of the Central and South American Cable Company. Now, what I do claim for my recorder is, that it is the most compact, the most readily adjusted, that the various parts can be removed and replaced as may become necessary more expeditiously and with less general disturbance than any other form of siphon recorder.

The signal coil is a new form requiring only one magnetic field, consequently the weight of the permanent magnet can be and is greatly reduced.

For the vibrator I claim that it is the only one constructed on correct scientific principles, that it works continuously and successfully on cables exceeding 2,500 knots in length, giving a line absolutely free from lateral vibrations, while at the same time the siphon is as free as though static electricity was employed as the motive power; with no other form of vibrator can this claim be made and sustained.

I therefore maintain that until the above remarks can be proven erroneous the right to claim the instrument under discussion as my invention is indisputable.—Yours, &c.,

CHAS. CUTTRISS.

Drexel Building, New York, February 7, 1888.

EXHIBITING INVENTIONS AT EXHIBITIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the notice in your issue of last Saturday respecting the Glasgow Exhibition, and in view of the several other exhibitions to be held this year in Brussels, Vienna, Munich, Melbourne, and elsewhere, will you kindly allow us through the medium of your space to caution inventors against the danger of exhibiting unpatented inventions under the 39th Section of the recent Patents Amendment Act.

This section is one of most misleading character, for while it purports to protect the invention during the exhibition, and to secure to the inventor unprejudiced rights against others, it now transpires, by recent decisions in the law courts, that the legal interpretation of the section is that it merely affords protection to the inventor as against *his own* acts, and that he is not protected against others copying, if they choose, his invention.

According to this interpretation, then, it is injudicious for any inventor to exhibit under the section in question, for while he, no doubt, acquires protection against the consequences of *his own* acts, he is simply exposing his invention for unscrupulous speculators to pirate, and probably deprive him of any benefits he may be entitled to in connection therewith.

The remedy is not to exhibit without first taking out provisional protection, a step which affords all the security desirable under the Patent Law.—Yours, &c,

J. K. FAHIE AND SON.

Patent Office, 10, Leinster-street, Dublin,
and 323, High Holborn, London, Feb. 20, 1888.

LIGHTNING DISCHARGE AT A CABLE STATION.—EFFICIENCY OF THE "SAUNDERS LIGHTNING GUARD."

The Eastern Telegraph Company's station at Porthcurno, near the Land's End, was visited on the night of the 14th inst. by a thunderstorm, which, although it only lasted about five minutes, was very severe.

The storm burst so suddenly that there was no time to put the cables to earth. In an instant the office seemed to be brilliantly illuminated, the sparks proceeding from the cable connections being so vivid as to dazzle the eyes, and in the test room the noise of the discharges was as loud as from a big electrical machine or the cracking of a whip.

The lightning appears to have struck near the front of the building without doing any damage to the structure, and passed through the test room. The land line connections are at the other side of the station, and nothing was noticed near their lightning protectors.

The recorder coils on the Vigo and Lisbon cables, which had Siemens lightning protectors only, were fused. It was at first thought that the coil of the Gibraltar instrument was fused also, but it is protected by a Saunders fine wire and tube protector, and to this fact its safety is attributed. The platinum wire was fused, and it did its work and saved the instrument, putting the cable to earth.

The Eastern Telegraph Company have often had reports of the efficiency of the Saunders lightning guard, which is in use at almost all their stations, but in this case the proof is so clear that in future it will in every case be used in addition to a Siemens plate guard.

MEETINGS OF SCIENTIFIC SOCIETIES.

TO-NIGHT (FRIDAY), February 24th.

SOCIETY OF ARTS.

8 p.m. Indian Section. "Facts Regarding the Religions of India, and their Influences on the Social Progress of the People." By Sir WILLIAM W. HUNTER, K.C.S.I., C.I.E., LL.D. The Earl of NORTHBROOK, G.C.S.I., will preside.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Supplemental Meeting for Students. Paper, "On the Erection of the Superstructure of the Forth Bridge." By Mr. ARTHUR J. KNOWLES, B A, Stud. Inst.C.E.

PHYSICAL SOCIETY OF GLASGOW.

Paper, "Conservation of Energy." By Mr. J. MACK, M.A.

ROYAL INSTITUTION.

9 p.m. Lecture, "Westminster Abbey." By the Very Rev. Dean BRADLEY.

SATURDAY, February 25th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Experimental Optics" (6). By Lord RAYLEIGH M.A., &c.

MONDAY, February 27th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III. "The Modern Microscope" (1). By Mr. JOHN MAYALL, Jun.

TUESDAY, February 28th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be read with a view to discussion—"Manganese in its Application to Metallurgy." "Some Novel Properties of Iron and Manganese." By Mr. R. A. HADFIELD, A.M.I.C.E.

ROYAL INSTITUTION.

3 p.m. Lecture, "Before and After Darwin" (7). By Mr. G. J. ROMANES, M.A., &c.

WEDNESDAY, February 29th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Discussion on Mr. SWIRE SMITH'S Paper, "The Technical Education Bill."

THURSDAY, March 1st.

CHEMICAL SOCIETY.

8 p.m Meeting.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

3 p.m. Lecture, "Early Secular Choral Music" (4). By Prof. C. H. H. PARRY, M.A.

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ANSWERS TO CORRESPONDENTS.

In reply to a correspondent, dating from "University College, Notts" (who omits to give his name), he should obtain Ayrton's "Practical Electricity," and Stewart and Gee's "Practical Physics;" Vol. I. "Electricity and Magnetism." For the more purely theoretical side he might consult Larden's "Electricity."

E.M.F.—*A letter awaits you.*

THE ELECTRIC LIGHT AND THE CITY.

In his speech at the Gas Light and Coke Company's half-yearly meeting reported in our last week's issue, Colonel MAKINS, the Governor of the Company, summed up the position of the rival illuminants by saying that "The electric light people have their sphere, and we have ours; and I do not think we need be afraid of anything they do or say." Nothing could be fairer or more sensible than these words; but, unfortunately, their natural interpretation has been falsified on the very first public occasion when their meaning was put to the test. At the meeting of the City Commissioners of Sewers on Tuesday last, the report of the Streets Committee recommending the adoption of the Electric Light for a certain area of the City was rejected—or, at least, referred back to the committee once again—by a majority of 36 to 17; and it seems to be generally admitted that the opposition was prompted and encouraged mainly by the Gas Lighting interests. For reasons which we will endeavour to make plain, the scheme submitted by the Anglo-American Brush Company, and approved by the Streets Committee (who have had it carefully under examination), cannot have been rejected on its merits; and the ostensible reason assigned for referring it back for reconsideration may be dismissed as unworthy of serious notice. An alternative proposal from the Maxim-Weston Company, or any other *bona fide* undertakers, might, indeed, be worth considering; but to drag in a competitor at the last moment, supported by arguments which tell against that or any other Electric Light company doing the work, shows pretty conclusively that the real opposition is directed not against the Brush Company's offer, but against invading the ground occupied by the gas company. Mr. SLY, who led the majority, strongly objected to granting a seven years' monopoly. As nobody could possibly undertake the job without having some sort of monopoly the objection tells equally against the Maxim-Weston Company, whose offer he professed to favour. We may take it, therefore, that, Colonel MAKINS notwithstanding, the gas interests are afraid of the Electric Light, and are doing

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their utmost to keep the "sphere" of the City all to themselves.

We are not without hope that the decision arrived at on Tuesday will be reversed. For one thing, the alternative scheme said to be submitted by the Maxim-Weston Company will not bear a careful examination. We have not the slightest desire to back up one scheme more than another; and we are absolutely indifferent as to what company gets the contract provided it falls into competent hands. This view we believe will be shared by every one of our clients, many of whom would be quite able to light the City as proposed, but who would, nevertheless, be sorry to see the Brush Company deprived of this undertaking, which they are well fitted to carry out, and for which they have some prior claims over any competitors. The Brush Company have had these negotiations on foot for several years past, have spent a considerable sum in promoting them, and are entitled to special consideration from the City authorities. The company are favourably situated for performing what they promise, they have suitable premises in more than one locality in the immediate neighbourhood, and nobody doubts their competency to do the work satisfactorily. They have had as large, if not larger, experience of this class of lighting than any other electric lighting company in this country, and quite recently they installed at the Manchester Exhibition nearly three times the number of arc lamps now proposed for the City of London. Now it must be confessed that nothing of this kind can be urged in favour of the only other competitor in the field. The Maxim-Weston Company are proposing to employ lamps, and, we presume, machines also, about which very little is known at present, and their competency to carry out such a work as is contemplated in the City—public arc lighting for the streets, and incandescent lighting by private contract for indoors—has yet to be proved. Moreover, the Maxim Company's proposal, if Mr. Sly's account of it is correct, embraces the whole of the City, and involves a payment down of £15,000 for first cost, a condition which, coupled with the magnitude of the undertaking—800 lamps of 450 candle-power against 169 of the Brush arcs of 2,000 candle-power—seems to us to stamp the proposal as utterly unacceptable, and only calculated to serve the purposes of obstruction.

Were the case one of genuine competition between several schemes of equal merit, no one would have a word to say against the City authorities giving to them the utmost possible attention. But in the actual circumstances we feel bound to say the Brush people have some ground for complaint against the Commissioners on account of their dilatory and indecisive attitude towards this question. It has long been admitted that the City is very badly lighted, that it ought to be lighted much better, that the electric light is a desirable substitute for the present system, and that a great number of citizens would be glad to use the new illuminant if it were placed within their reach. Notwithstanding these undeniable facts, the one and only substantial argument which has prevailed so far to delay the introduction of the electric light on a permanent footing is that it will cost so much more. No doubt it will; but so would an increased supply of gas to light the City adequately—an increase which the public rather deprecate than desire. Without a considerable additional charge the City cannot be lighted properly; and the chief question remaining, after admitting the superiority of the electric light, is whether the terms offered by the Brush Company are fair and just? This, too, is not disputed—unless Mr. Sly's very questionable alternative can be said to dispute it—the general opinion of the Streets Committee, who have gone carefully into the figures, being that £26 per lamp per annum for 169 lamps giving 30 times more light than the present gas lamps, which cost quite half as much, is a price which by itself will not pay the Company for their outlay, their chance of a profitable return being in the private custom they expect to secure from shopkeepers, printing offices, warehouses, and the like. And this view of the figures is probably correct, judging by what is being charged elsewhere both in this country and in America. In some part of the States the tariff per arc lamp per annum is very much higher; in Philadelphia, for example, it is £40 and even in New York, where the area of operations is much larger and the ascendency over gas far more complete than is at all likely in this country, the charge averages nearly £20 and taking the States all round it ranges probably between these two extreme figures. One thing, therefore, is pretty certain—the City of London cannot have the Electric Light for less than what the Brush Company, trusting to private patronage, consent to charge.

We have just remarked that the competition of the Electric Light as an illuminant is far more serious in America than it is in England, where gas is much cheaper; and we could have wished that Mr. J. C. Bell, who moved the adoption of the Committee's Report, had appreciated this fact, and held his tongue about "the gigantic gas monopoly." The gas companies can no more be reproached for being gigantic than for being monopolists. That they are gigantic may be a good reason for their giving fair play to a not dangerous and much needed rival; but that they are monopolists in this relation is contradicted by the very terms of Mr. Bell's motion. The gas manufacturers have a monopoly for the supply of gas, that is all. No one proposes to confer a like monopoly on the Brush Company, although Mr. Sly talked as if this were the case. There are, as we have already stated, a great many private installations in the City, and neither with these nor with their further increase, except by open competition, can the Brush Company interfere under the terms of its seven years' concession. All that is conceded is the exclusive right to open up the streets for the purpose of laying down mains, and certainly nothing less than this could be accepted by the undertakers whoever they might be. It is to be hoped that these considerations may induce the City Commissioners of Sewers to reconsider their vote when next the subject comes up for discussion.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, *Feb.* 11*th*, 1888.

With the nearer approach of spring, electric railways are beginning to attract more and more attention, and there is promise of greater activity in this field during the present year than ever before. Extremely interesting reports come to hand from Richmond, Va., where for some months past an electric railway has been in course of construction by the Sprague Electric Motor and Railway Company. This electric road is at once the largest and the longest ever attempted. It includes nearly 13 miles of track, and the main portion is double-tracked for a distance of about two miles. The overhead system is used, with ground return. The grades run up in some cases as high as 10 per cent., and there are no fewer than 31 curves. The main conductor is a copper wire $\frac{3}{16}$in. diameter, which carries a current of 500 volts. In order to maintain the E.M.F. constant, four-feeder wires are employed, tapping into the main line wire at different points. This line wire is carried by 30ft. poles 125ft. apart, and connects with the working conductor, which is suspended across the track at a height of 13½ft. from the ground. The trolley contact is employed, but I understand that the final

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form has not yet been arrived at; the idea is to make contact from the underside of the conductor. The full equipment of this road will comprise 40 cars with two motors each. The motors have a nominal capacity of 7½ horse-power each, and will develop up to fifteen, thus providing ample power for a car heavily laden on the steepest grades and sharpest curves. The current for the motors is generated at a very fine station, located midway in the line, and fitted up with three large cylindrical return tubular boilers, three 125 horse-power high-speed engines of Armington-Sims make, and six Edison dynamos of 40,000 watts each. It will be seen from these details that the undertaking is one of great magnitude; in fact, it was admitted that it was impossible to work the road with horses, and it will be seen that the much vaunted cable would have had very little opportunity of demonstrating its merits. To operate such a road by electricity is no small triumph for the art, and for Mr. Frank Sprague personally. That gentleman in developing his system of stationary motors brought on a very serious attack of illness, and his condition at one time was grave; but no sooner was he halfway toward recovery than he put himself to the task of equipping this road, which had up to that time been in the hands of his staff. It is largely due to Mr. Sprague's own genius and efforts that the road is in its present advanced and encouraging state. It is practically a success to-day, in spite of the initial mechanical and electrical difficulties that had to be overcome, and all the troubles incurred in running on a new track badly laid in a clay soil, submerged by winter flood. The road is in active service to-day, and I understand that Mr. Sprague expects to have it in just such shape as he would wish, by the end of March. This is the first piece of the kind that he has undertaken in person, and he has used the opportunity to carry out one or two experiments the results of which will be of use in other and further work. Meantime another Sprague road in the south, that at Wilmington, Del., has just gone into successful operation.

Turning from Richmond to Pittsburg, we find the Bentley-Knight Electric Railway Company operating its new road with success in Allegheny City, the suburb of the smoky manufacturing centre. The Bentley-Knight Company, as you are doubtless aware, has been engaged for some time in elaborating its system, and is understood to have done some very thorough work, both in its experiments and in securing its comprehensive patents. Its strength may be inferred from the fact that the powerful Thomson-Houston Electric Company has entered into an arrangement with it, by which the said company is to furnish motors for the Bentley-Knight system, and to push the business through its 300 sub-companies. To return to Allegheny City. The road there, as in Richmond, presented some enormous grades to be worked, reaching in one part no less than nearly 10 per cent. The road also presents the interesting feature of being one in which both the overhead conductor and the conduit are used. The present equipment consists of four cars, each of which carries two 15 horse-power Thomson-Houston motors, and the trolley and the plough for overhead and subway contact. There are eight miles of conductors. The station is equipped with a 200 horse-power Buckeye engine and four Thomson-Houston generators, and natural gas is used under the boilers. The cars have made on the road a speed of from 15 to 18 miles an hour through snow and mud. The plough is said to work very well in the conduit, and is so constructed that it can be jerked out of the slot immediately. The success of the section of conduit in use at Allegheny City would augur well for the success of the system here, in New York City, whenever the company is able to overcome the legal difficulties which prevent it from operating its Fulton-street line. Fulton-street is one of the busiest thoroughfares in New York, and is greatly in need of a street car line. The company which is to use the Bentley-Knight system has a franchise for the road, has already laid its rails, and would like very much to put in its conduit and its steam plant; but other street railway companies, whose tracks it would cross, are displaying a dog-in-the-manger spirit, and will not give it right of way. In this emergency an appeal has been made to the Legislature, which will, it is to be hoped, break the deadlock. We have less engine storage cars running in New York City, but what is wanted to thoroughly advertise business is just such a road as this on Fulton-street. Of course when the electric light convention meets at Pittsburgh a week or two hence, the Bentley-Knight road there will be one of the centres of attraction; but not everybody interested can go to Pittsburgh.

I saw the other day a communication in one of the Boston papers, from its City of Mexico correspondent, with regard to the use of the electric light in the land of the Montezumas. He notes the use of two English systems at the capital, the Swan and the Crompton, and of three American, the Edison, Thomson-Houston, and Fort Wayne-Jenney. He says that of late there has been great competition among the shopkeepers in securing the incandescent light for their show-windows, and that the taste for the electric light is spreading to other cities in the Republic. The Edison light is in use in the offices and other public places. The Gas and Electric Light Company is putting in a Swan system with the pledge that the monthly bills of its customers shall not exceed their gas bills. Gas is sold at the rate of 21s. 8d. sterling per thousand. Some idea of the cost involved in the manufacture may be arrived at from the statement that coal costs £3 per ton sterling, and wood £1. 17s. 6d. per cord. It is extremely fortunate for the company that the climate of Mexico is not cold.

I made in my last letter some comment on the favourable attitude of the mayor of this city, Mr. Hewitt, with regard to storage batteries, electric light and electric motors, and I must speak well of him for the action which he has just taken with regard to telegraph schools. There are in this country a number of swindlers who impose on ambitious young people, advertising to teach them telegraphy in a few weeks, when they can take positions guaranteed at from £150 to £300 a year. These schools, I am sorry to say, flourish in all parts of the country, and as they do actually, in some sense, give instruction, and as their guarantees are purposely vague and indefinite, it is very hard to bring them within reach of the law. All those who are familiar with telegraphic work know that the lower ranks of the profession are very crowded, and that so far as any demand exists for new material it is best satisfied by that which is furnished in the telegraph offices themselves, in the messenger boys and others who grow up in the business from its very foundation, and, as they display aptitude, get their chances of promotion. But these facts are not known to the guileless youths who flock to the telegraph schools, and the consequence often is that, after spending money which they have pinched themselves and their friends to obtain, they find themselves without a position and in absolute want. Mayor Hewitt has, as I have said, tried to put down this swindle, and as the law could not help him, has resorted to the novel method of placing a policeman in front of the school, the duty of the officer of the law being to warn away all would-be pupils. A better method of shutting up such places could hardly be hit on, and it is successful. As the schools have to advertise themselves in the daily papers in order to attract victims, it is hard for them to conceal their whereabouts, and hence the proprietors are feeling intensely disgusted. They will not vote for Mayor Hewitt's re-election. It is to be understood that no objection is taken to what one may term legitimate instruction in telegraphy. Such, for instance, as that given at the Cooper Institute, the magnificent people's university, founded by Mr. Hewitt's own father-in-law, the philanthropist, Peter Cooper. But even such places, it is to be feared, turn out more graduates than telegraphy can find room for, and the consequence is that the salaries of the operators are kept down.

Associated Chambers of Commerce.—At the meeting of the Associated Chambers of Commerce this week resolutions were passed in favour of the control by Government of telephonic communication, and also the establishment of telegraphic money orders.

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INCANDESCENT LAMP SWITCHES.

We herewith illustrate some new designs for incandescent lamp switches by Messrs. Fowler, Lancaster and Co., of Birmingham. Figs. 1 and 2 represent a pendant switch, which can be used with or without the lamp attached, the novel feature being that the lamp can be put on or off with the hand only. Fig. 2 represents the interior arrangement, from which it will be seen that a sliding bar of ebonite carries a cross-piece of metal, by which rubbing contact is made between two stiff springs connected with the terminals. In the second position, when the lamp is off, the two springs rest upon an ivory stud which passes through the sliding bar above the contact piece. In this position the springs are more widely separated. Taking the holder in one hand it is easy to slide the bar into either position with the pressure of the thumb. The outer case is made of white china. Messrs. Fowler, Lancaster and Co. also send for our inspection several other patterns of lamp switches and fuse blocks of good design and handsome appearance,

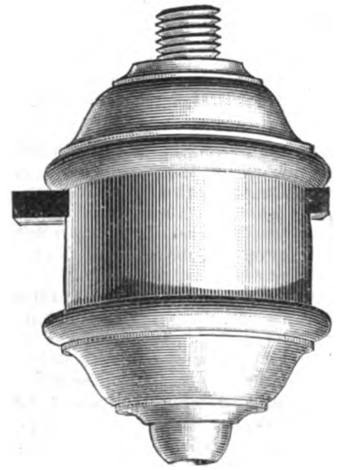

FIG 1.

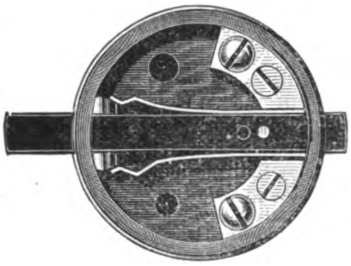

FIG. 2.

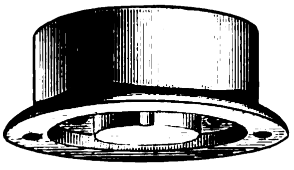

FIG. 3.

white china being used throughout. The backs of these switch-blocks are made with a deep groove to receive the bend of the wire as seen in Fig. 3. The fuse blocks are well adapted to receive the Cockburn fuse, with which some of them have been fitted.

ELECTRIC LIGHTING IN GERMANY.

At a recent meeting of the German Association of Gas and Water Engineers, Dr. Schilling read a long report on the position of electric lighting in Germany. Dr. Schilling commenced by remarking that, in dealing with the subject of the commercial development of electric lighting and its bearing upon the question of gas supply, attention should be called to the fact that the notable progress which the former system of illumination has made of late years, has been in great part due to establishments situated in districts outside the area served by gas works; although, at the same time, considerable advance has been witnessed in several German towns lighted by gas. He then proceeded to give statistics in support of these statements. It appears therefrom that in thirteen German towns the number of electric lighting establishments has risen, during the past two years, from 138 to 604; the number of arc lamps in use, from 591 to 3,280; and of incandescent lamps, from 10,403 to 50,469. It is in these thirteen large towns that electric lighting has made the greatest progress since its adoption. But there are still many small towns entirely without this kind of illumination. The number of gas burners used in the above-mentioned towns is about 1,221,882. Electric lighting, therefore, is in the proportion of about 4 per cent. to the latter figure. Taking all the towns in Germany, the proportion of electric appliances to gas burners is nearly 2 per cent. Two years ago it had not reached 0·5 per cent.

Berlin has the largest number of electric lamps. Some are served from two central stations belonging to the "Society of Shareholders of the Electric Supply Works of Berlin;" others from establishments started for the supply of blocks or groups of houses; others, again, from private establishments producing electricity by means of steam or gas engines. According to reports made up to April last, there were then altogether about 333 establishments, supplying 1,554 arc lamps of various types, and 22,363 incandescent lamps. Of these 333 establishments, 163 are carried on by the above-named society, and supply 116 arc and 9,306 incandescent lamps. At the time of writing Dr. Schilling's report, there were four large establishments for the supply of blocks of houses, viz.:—(1) The Shadowstrasse station, consisting of a steam engine of about 75 horse-power, supplying 4 arc and 612 incandescent lamps; (2) the Friedrichstrasse station, consisting of a steam engine of 200 horse-power, supplying about 5 arc and from 750 to 800 incandescent lamps; (3) the Passage station, consisting of three steam engines of 60 horse-power, supplying 52 arc and about 1,500 incandescent lamps—all set up by Messrs. Siemens and Halske. There is to be a fourth station—the Beuthstrasse—to consist of two engines of 80, two of 28, and one of 48 horse-power. This establishment is not yet in full working order; only 36 arc lamps, of 11 amperes intensity, set up in the Leipsigerstrasse, being supplied with the electric current.

Next after Berlin, Munich has the largest number of electric lamps, and in proportion to its importance has made the greatest progress in electric lighting. According to the latest reports, this city possesses forty-three establishments, supplying 167 arc and 7,936 incandescent lamps. This represents a proportion of 8 per cent. to the number of gas burners employed in the public lighting. In Munich there are also important electric establishments at the Imperial Theatre, which is lighted by 2,300 incandescent lamps; the Imperial Ministry of War, lighted by 800 lamps; the States Chamber, which has almost as many; several large breweries, which utilise their surplus steam for electric lighting purposes; and the markets on the quays of the Imperial Central Station. Eighteen of the above-mentioned establishments employ gas engines; and it should be pointed out that there is no central electric lighting station in Munich.

Hamburg has at present 70 electric lighting establishments, supplying nearly 300 arc and 4,500 incandescent lamps, of which about one-fifth are operated by means of gas engines. The most important establishment is a central station started in 1885 by a limited liability company, and able to supply nominally about 1,000 lamps; but as yet it is only in partial working order. Another establishment of nearly equal importance, and intended almost entirely for the supply of electricity to be used on the spot, is in an immense café; and another station, capable of supplying about 500 incandescent lamps, is in course of construction near the Bourse. Since 1882, the Municipal Council have established a station for supplying the Senate Chamber and its annexes; also one for lighting the Place de l'Hotel de Ville, which supplies 16 arc lamps; and another for lighting three covered wharves by means of 9 arc lamps. Within the Free Port, the warehouses are lighted by an establishment supplying about 50 arc and 4,000 incandescent lamps. This establishment was founded by the Free Port Warehouse Company, with the financial help of the Caisse Publique of Hamburg. Other establishments for the supply of the Free Port are projected. The Municipal Authorities also propose to set up a central establishment to serve 10,000 incandescent lamps, but capable of supplying twice this number.

In Vienna the most important electric lighting establishment, when Dr. Schilling prepared his report, was at the new Hotel de Ville, supplying 577 incandescent lamps; but it was to be enlarged so as to be adequate to supply 947 lamps. The two Imperial theatres are, as our readers are aware, lighted by the establishment of the Imperial Continental Gas Association. The city has besides 59 private establishments, comprising 90 dynamo-electric machines, which supply 248 arc and 5,846 incandescent lamps. Of these establishments 24 employ gas engines.

Coming to places of less importance, we find that Leipzig possesses 23 establishments, of which 13 employ gas and 10 steam engines. Of the total number, there are 21 private and 2 central establishments, supplying 256 arc and 3,459 incandescent lamps. Of the entire number of lamps, 1,410 are served by gas engines and 2,395 by steam engines. Crefeld has 44 establishments in all, supplying 175 arc and 3,209 incandescent lamps, being in the proportion of 6½ per cent. to the number of gas burners used. These lamps are distributed among 18 silk and velvet, 6 glass painting, and 8 dying works, and 12 other factories of various kinds. One special station supplies an arc lamp and 445 incandescent lamps. Five establishments, supplying together 9 arc and 441 incandescent lamps, employ gas engines; the others use steam engines. The exceptional conditions under which business is carried on at Crefeld, and more particularly the supersession of handwork by mechanical labour, which has become preponderant during recent years, constantly affords manufacturers facilities for installing the electric light. Cologne has 33 establishments, which supply 101 arc and 2,727 incandescent lamps. Sixteen of these establishments employ gas engines, and the remainder steam engines. Some central stations are in contemplation. Dresden has 30 establishments in all. They supply 157 arc and 2,379 incandescent lamps. In 14 of these establishments, supplying together 78 arc and 470 incandescent lamps, gas engines are employed; but in the others existing steam engines are almost exclusively utilised. At Barmen, electric lighting is almost in the same condition as at Crefeld. There are 28 establishments, supplying 226 arc and 2,251 incandescent lamps, nearly all in manufactories, and all employing steam engines. Chemnitz has 39 establishments, fitted up for the

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most part in manufactories, and supplying 503 arc and 1,646 incandescent lamps. The electric lamps are in the proportion of about 4½ per cent. to the number of gas burners. But it must be taken into account that, among these electric lamps, there are a large number of the arc type. Breslau contains 27 establishments, supplying 123 arc and 1,932 incandescent lamps. Eleven of these establishments employ gas engines. The Municipal Authorities are desirous of setting up a central station; but the matter is awaiting the decision of a commission.

An important example of the competition of electric lighting with gas in Germany is furnished by the statistics relating to the group of towns supplied by the German Continental Gas Company of Dessau, of which Herr Oechelhaeuser is chief engineer. In eleven of these towns there are altogether 230 arc and 3,540 incandescent lamps in use, of which 13 of the former and 1,297 of the latter are supplied by machines actuated by means of gas engines. But 51 arc and 596 incandescent lamps were fitted up by non-consumers of gas. At Dessau there is a central electric station. The towns of Mulheim-on-the-Ruhr, Krakau, Lemberg, Essen, and Herbesthal had not any electric light at the time Dr. Schilling's report was prepared.

In the next two towns dealt with—Halle and Stuttgart—the theatres stand out conspicuously as favouring electric lighting. In the case of the former town, it was at the theatre that the new system of illumination was first adopted; the installation comprising 16 arc and 1,402 incandescent lamps. But beyond this there are within the lighting area at present only three manufactories illuminated by electricity; and they employ altogether 17 arc and 109 incandescent lamps. Outside the town, a paper mill and a brewery are lighted by electricity—the former by 10, and the latter by 18 arc lamps. The Royal Theatre at Stuttgart has nearly 1,000 incandescent lamps employed in its illumination; but the railway waiting rooms and platforms are lighted by arc lamps. Besides these there are six establishments which serve together 37 arc and 220 incandescent lamps. Coming north again, we find that in Brunswick, out of 15 private electric lighting establishments, 12 supply (together) 109 arc and 1,014 incandescent lamps. Not long since a project was started to light by electricity a block of houses very favourably situated for the purpose. Going westward towards the Rhine, we learn that in Elberfeld there are ten private establishments in operation; and that in the course of the winter of 1886 a company was successful in obtaining permission to light a block of houses with about 250 lamps. An attempt to secure a second concession for another part of the town failed. At the time Dr. Schilling was preparing his report, the Municipal Authorities were taking steps to establish a central lighting station on their own account.

In a group of towns (thirteen in number) lighted by the General Gas Company of Magdeburgh, there are six which have not yet adopted the electric light. In the remaining seven there are 51 arc and 581 incandescent lamps in use. Of the 22 towns supplied by the Gas Company of Thuringa, five are as yet without the electric light; while in the rest, 359 arc and 5,762 incandescent lamps are employed. But the greater number of these installations are in connection with manufactories situated, for the most part, beyond the company's lighting area in the several towns.

The whole of the other towns included in Dr. Schilling's report may be dealt with in a single paragraph. Carlsruhe has eight establishments, supplying 134 arc and 321 incandescent lamps. Three of these establishments are outside the area lighted by gas; and in two others gas engines are employed. Szegedin has four establishments, supplying 2 arc and 378 incandescent lamps. Offenbach has five establishments, supplying 69 arc and 219 incandescent lamps. In Heidelberg there are four manufactories lighted by 13 arc and 255 incandescent lamps. In three cases the dynamos are driven by steam engines, and in the fourth case by turbines. In Ratibor the manufactories include five installations, supplying a total of 24 arc and 312 incandescent lamps. Dantzig has seven establishments, supplying 11 arc and 300 incandescent lamps. In two of these cases gas engines are employed; and three are beyond the gas supply radius. In Deutz and Kalk there are six large manufactories, some lighted by both gas and electricity, and others by electricity only. A proposal was submitted to the authorities by an electric lighting company to set up a central station, and supply the public lamps gratuitously, on condition that a 12 years' concession was granted to them; but the offer was declined. In Charlottenburg, the villa of Mr. Siemens is lighted by 2 arc and 320 incandescent lamps; and the works of Messrs. Siemens and Halske by 22 arc and 50 incandescent lamps. Three private houses and a timber yard are also electrically lighted. Two manufactories at Hof are lighted by 292 incandescent lamps. At Mayence the platforms and some other portions of the central station of the Louis of Hesse Railway are lighted by 24 arc lamps; and there are three other establishments, having together 10 arc and 199 incandescent lamps. Salzburg has four establishments, supplying a single arc and 80 incandescent lamps, all by means of hydraulic power. A central station is contemplated. Traunstein has two establishments, using 5 arc and 75 incandescent lamps. Pforzheim has only two establishments, having about 50 incandescent lamps in all. In an ironfoundry in this town the use of arc lamps has been given up, after two years' trial. Kiel, as far as the town itself is concerned, has only one house lighted by electricity; but a freighter in the port uses some arc lamps for loading and unloading. On the other side of the port (which is not a part of the town) the works and storehouses at the Imperial Dockyard are lighted by arc and incandescent lamps; but they are only used to expedite the building of war ships. The electric light is employed at a large flour mill at Neumühlen; also at a dockyard, a manufactory, and an ironfoundry at Diedrichsdorf. All the war ships are lighted by electricity. Altona has at present only two places—pleasure gardens—electrically lighted; and in these cases arc lamps are employed.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED.)

At the moment of going to press we have received the following report of the Directors to be presented at the seventh ordinary general meeting, to be held at the Cannon-street Hotel on Friday, March 2nd, at 12 o'clock noon:—

2. During the past year there has been renewed activity in the electrical industry both at home and abroad, and although in the present state of electric lighting the business still calls for sacrifices out of proportion to the rewards it offers, there are indications that it is entering upon a new phase, and the Directors have reason to hope that the time is now not distant when the work done by the Corporation will be of a sufficiently profitable character to admit of the regular payment of dividends. The electric light is becoming more and more to be regarded as the light of the near future. Clubs, hotels passenger steamers, and war ships are not considered complete unless provided with the electric light, and in the case of theatres lighting by electricity is now recognised as one of the necessary precautions against danger from fire. Municipalities also, whether they own gas works or not, are showing an increasing inclination to encourage the establishment of central stations for the supply of electricity.

3. The Board have therefore continued to pursue the policy fully explained in the last report of developing the business of the Corporation, and of anticipating as far as possible the demands which will arise in connection with the carrying out of both public and domestic lighting on a large and commercial scale. With this view patent rights have been secured in connection with the distribution of electric currents of a high electromotive force to be distributed over large areas, and transformed to a low tension for domestic purposes. Considerable progress has been made by the Corporation, in common with others, with this system of distribution, as well as with that by means of accumulators, and the Board are now negotiating in several directions for contracts for the establishment of Central Stations for the supply of electricity. In matters of detail the Corporation have made appreciable advance during the year—in the further improvement of their machines and other apparatus, to the better organisation of the business, and in increasing the aggregate amount of their transactions. It is to be regretted, however, that owing to competition and consequent reduction of prices, profits have not increased in anything like the same ratio as the volume of business.

4. Among the satisfactory features of the year's work may be mentioned the lighting of the Royal Jubilee Exhibition at Manchester, by means of nearly 600 arc lamps, to the entire satisfaction of the authorities, and the success which attended this work has materially contributed to the Corporation receiving the contract for lighting the largest part of the forthcoming exhibition at Glasgow by means of 500 arc lamps. The Corporation also took an important part in the lighting of the American Exhibition in London. They have also carried out a large number of installations in clubs, theatres, on board ship, &c., some of the more interesting being the Lyceum Theatre, Edinburgh, the installations on board the Peninsular and Oriental Company's steamships "Victoria," and "Britannia," the hall of the Worshipful Company of Drapers, and the Royal Albert Hall.

5. The long pending negotiations with the Commissioners of Sewers for the lighting of a part of the City of London have been pushed forward with energy, and although a definite decision has not yet been arrived at, the Board trust that the matter will speedily be brought to a satisfactory conclusion.

6. It was stated in the last report that the Corporation had acquired the business of the International Electric Company in Austria-Hungary. During the year this business has been energetically developed, and there are good indications that it will constitute an important source of revenue to the Corporation. The firm of Kremenezky, Mayer and Co., in Vienna (under which title the Corporation are there trading), have carried out a variety of satisfactory contracts during the year, whilst at Temesvar, in Hungary, where upwards of thirty miles of streets are lighted by electricity, the Corporation have, since taking over the installation, materially increased the efficiency of the plant, and reduced the expenses of working, so that the balance is now on the right side, and the Corporation, having undertaken to supply the light to private consumers, are taking steps to extend the capacity of the works.

7. In the previous report the Directors referred to the litigation which was then pending in regard to the infringement by a few manufacturing firms of the patent held by the Corporation for compound

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winding of dynamos. The Directors are glad to be able to report that the suit has been amicably settled out of court, Messrs. Crompton and Co. and their colleagues having accepted licenses from the Corporation upon the usual terms, and paid a sum of money in satisfaction of past royalties and legal costs incurred. In connection with this case it became necessary to take the evidence of Mr. C. F. Brush, in America, by commission, and Mr. Percy Sellon, the Corporation's electrician, who was entrusted with the mission, obtained evidence which, as was anticipated, confirmed the position of the Corporation with regard to this matter. Licenses to manufacture compound wound machines, under the Corporation's patent, have now been accepted by all the leading dynamo manufacturers in this country, including Messrs. Siemens Bros., Messrs. Crompton and Co., the Edison-Swan Company, Messrs. Mather and Platt, Messrs. Ellwell-Parker, Messrs. Greenwood and Batley, the India Rubber and Gutta Percha Company, Messrs. Goolden and Co., Messrs. Paterson and Cooper, and many others. One firm of manufacturers in Scotland have as yet declined to accept the very moderate terms demanded by the Board, and for the protection of the licencees of the Corporation the Board have lately instituted proceedings with a view to prevent the infringement of their rights.

8. The cross actions with the Edison-Swan United Electric Company, in which the Corporation were involved at the time of the last report are still pending, but are expected to be heard shortly. This litigation, while exceedingly to be regretted from its serious character to your interests, is, however, of far graver importance to the Edison-Swan Company, involving as it does the validity of the most important of their incandescent lamp patents, which, as would appear from their balance-sheet, stand at about £300,000, and upon which they rest their claims for an absolute monopoly of lamp making. The Board take this opportunity of placing on record their regret that their efforts to bring about an amicable settlement, consistent with your interests, have failed, and that everything points at present to the necessity of the case being submitted to the final decisions of the Courts of Law. The Board have, however, given their careful consideration to the matter, and have spared no trouble or expense to ensure success in the Law Courts, and the great strength of the evidence they have been able to collect, combined with the high legal and scientific advice by which they are guided, enable them to state their full confidence in the result.

9. The Bill introduced last session by Lord Thurlow to amend the Electric Lighting Act of 1882, based as it was in a large measure upon the evidence taken by the Select Committee of the House of Lords in 1886, was very favourably received, and passed by that House, the Prime Minister expressing the opinion that the enterprise should be allowed full scope, that all obstacles which had hitherto impeded it should be removed, and that terms should be offered which experience had shown capitalists would accept. The prospects of carrying the Bill through Parliament were therefore very good, had it proved possible to proceed with it in the House of Commons last Session. The Bill has been, however, reintroduced by your chairman, and there appears a reasonable prospect that it will become law this Session.

10. The capital account shows an increase of £34,939. This is due to carrying into effect the agreement with the International Company, already referred to, which involved the issue of 1476 fully paid shares, and to the issue of 1,354 new shares, under the resolution passed at the last meeting, giving the Directors power to issue new capital for the purpose of developing the business. Owing, however, to the fact that this new issue was not largely responded to at the time, the Directors thought it expedient to make a call of £1 per share upon those shares upon which the sum of £3 only had been paid.

11. The increase in the patents, development, and goodwill account of £3,580, is due mainly to the re-acquisition from the Eastern Electric Light and Power Company, in liquidation, of the Brush and Lane-Fox patents for the whole of the Indian Empire, exclusive of those for the Presidency of Bombay and the Nizam's Dominions, which had already been disposed of by the liquidators. The increment includes also the unrealised balance of the assets realisation accounts, which appeared in previous balance-sheets in connection with the absorption of the Great Western and Brush Midland Electric Light Companies, and which has been so dealt with in accordance with the principle laid down at the time of taking over those Companies, and the payments during the year for up-keep of patents.

12. It will be seen from the balance-sheet that there is a marked increase in the amount owing to the Corporation, which evidences the larger volume of business.

13. It will be perceived that, despite the larger operations conducted during the year, the general charges show a reduction of about 5 per cent. Several of the economies effected by the Directors now appear in the accounts for the first time; amongst these may be mentioned a reduction in comparison with the previous year of nearly £500 in carriage and freight, owing to an alteration in the classification of electric apparatus, which was conceded by the railway companies in the early part of the year, as the result of representations made by the Corporation. The Directors have also been successful in effecting several other and larger economies, which however are not yet reflected in the accounts. Among these may be more particularly mentioned the surrender of the lease of the premises at Portpool-lane, and of the recent sub-letting the Borough-road works.

14. The item of gross profit, which shows a substantial increase upon last year's figure, includes the amount of £3,132, being the estimated value of the fully paid shares in the International Company held by the Corporation, and which were relinquished as part consideration for the Austro-Hungarian business. The gross profit strictly due to the current business shows an increase of about 12½ per cent. The Directors propose that of the balance of profit £2,500 be added to provision account, and that £2,562. 12s. 1d. be carried forward to next account.

15. The Directors, following the precedent of numerous other industrial undertakings, have, after mature consideration, decided to adopt the principle of remunerating the chief officers in proportion to the net profits distributed by the Corporation. The arrangement is that an amount equal to 10 per cent. of the dividend declared shall be set aside as a fund to be divided, in proportion to salary, amongst the officers from time to time nominated by the Board under specified conditions. The Board are satisfied that the adoption of this plan will, in view of the appreciation expressed by the staff, have results highly beneficial to the proprietary, and the Board therefore cordially recommend it for adoption by the shareholders.

16. Owing to pressure of other engagements, Lord Sudeley found it necessary last spring to vacate his seat at the Board, and in July last Major-General Webber exchanged the position of managing director for that of consulting technical adviser, an office which in view of the immediate prospect of street and private lighting contracts, is one of daily increasing importance to the Corporation.

17. The Directors who retire this year by rotation are Mr. J. S. Sellon and Mr. J. B. Braithwaite, jun., who, being eligible, offer themselves for re-election. Messrs. Cooper Brothers and Co., the auditors, also retire, and offer themselves for re-election.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

The discussion on Mr. Kapp's paper on Transformers, and that of Mr. Mackenzie on the same subject, was commenced on Thursday, the 16th inst., Mr. W. H. Preece, F.R.S., in the chair.

Prof. AYRTON congratulated the authors upon their most interesting communications on a subject which was all important at the present time. He agreed with Mr. Mackenzie that a good deal of credit was due to Messrs. Gaulard and Gibbs, not for having invented a new method of distributing electrical energy, but for having drawn attention in an experimental way to that method at the Exhibition in the Aquarium in 1882, and for having persistently worked at the system. Many of them who saw the secondary generator at the Aquarium had no idea that in a few years it would form the system employed on the largest distribution of electrical energy in this country. Perhaps one reason why some of them did not appreciate at once the full importance of the employment of transformers was because they felt that when the measurements shown them were made so extremely incorrectly, possibly the system might be as unsatisfactory as the methods employed to measure its efficiency. Of course, that in no way detracted from the advantages of transformers, and he merely put it forward as a reason why he and his colleague, at any rate, did not fully appreciate at once the importance of transformers when Messrs. Gaulard and Gibbs exhibited their transformer at work in 1882. For example, the potential difference at the terminals of the transformer was then measured by means simply of a high resistance dynamometer, and that was multiplied by the current as measured by a low-resistance dynamometer, and the conclusion was at once jumped to that the product measured the watts put in or the watts given out, as the case might be, and in this way an efficiency was arrived at which might or might not have some connection with the true efficiency of the transformer. *Two* errors were made in that sort of measurement—to measure alternating volts with a high-resistance dynamometer was wrong; and to multiply the volts, even if correctly measured, by the current did not give the watts if the circuit contained self or mutual induction any more than the mean pressure of the steam in the cylinder of an engine multiplied by the number of revolutions per minute gave an answer proportional to the horse-power developed by the engine independent of the time the steam was cut off at each stroke. Therefore one felt, in 1882, more inclined to be guided by the fact that the core of the transformers was extremely hot in concluding that the system, at any rate as it then stood, was not particularly good, rather than by the results of experiments which were obviously incorrect. Nevertheless it did seem, in spite of that, that the system, as now developed, was an extremely good one. That was shown by the fact that it was used very extensively, as described at the end of Mr. Mackenzie's paper, in the United States. The next point that perhaps would suggest itself in this discussion was the question of safety to life. Of course they were dealing, or might be dealing, with a very high potential difference in the primary. How could they take care in the easiest way to avoid danger when people touched the secondary? A very ingenious device, due to Mr. Kent, was described by Mr. Kapp, and he also showed an equally ingenious arrangement of Captain Cardew's. It appeared to the speaker and his colleague that there was a far simpler device—a device merely consisting, as indeed was suggested by his colleague and himself some years ago, of putting one wire of every secondary to earth. Proper insulation was established between the primary and secondaries, and it did not affect the insulation of the primary circuits in the least, whilst it ensured perfect safety in the secondary arrangement without the use of any particular fuses or automatic motive device. It also had this advantage, that it prevented their getting a shock from the electrostatic capacity of a transformer, which might be considerable. It had been rather held by the authors of the papers that it was impossible to use

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transformers *in series* if they wished to maintain constant potential difference at the terminals of the secondary when the resistance of the secondary circuit was altered; that is to say, if the number of lamps in parallel in the secondary circuit was varied. There was, however, a method of producing constant potential difference in the secondary with constant (mean alternating) current in the primary, which it appeared to him would lead to good results. The method was analogous with the compound-wound dynamo. In a compound-wound dynamo they had a series coil, which increased the magnetisation of the field-magnet when the current of the outside circuit was increased. They could get exactly the same thing with transformers. Supposing the secondary coil S (Fig. 1) were joined in the ordinary way to the lamps L, let there be in addition a second induction coil, S′ T, the primary of which S′ was in series with S and the secondary T, so joined up that it added a potential difference to the secondary circuit and added the greater potential difference the greater the current passing through the secondary. That arrangement was exactly the arrangement of a compound-wound dynamo; the tertiary coil would correspond to the series coil of the compound-wound dynamo. That was to say, a constant current passing through the primary coil P, would produce a constant electromotive force in the secondary S, and a potential difference would be added to the secondary circuit, the added potential difference being the greater the greater the current in the secondary circuit S. At any rate, he believed it might be possible by such an arrangement to do this, and so obtain a transformer capable of working in series. That idea occurred to his colleague and himself some three or four years ago, but as they found great difficulty in working out the currents in the primary, secondary, and tertiary coils mathematically, they thought they should do better by resorting to experiments. An apparatus was made, and, indeed, it was for these experiments that the little voltmeter which they brought before the society at the end of last year was originally devised. Their transformers were little things, and so they found it was necessary to measure a few volts—alternate potential difference—accurately, and therefore they wanted a voltmeter to measure four or five alternate volts accurately. When their experiments were about to start he came across an account published, if he remembered rightly, by Messrs. Gaulard and Gibbs, putting forward exactly the same device which those gentlemen had then just covered by a patent. He would be very glad to hear from Mr. Mackenzie whether this system was seriously tried. Had he not come across this description of a precisely similar method of compounding transformers, he and his colleague would certainly have pursued the matter, but they left Messrs. Gaulard and Gibbs to do it, and, curiously enough, nothing more had been heard of it. He was very glad to see that the idea of magnetic lag, which means a retardation of iron to be magnetised, was gradually gaining acceptance, especially in consequence of the admirable work that had been done on this subject by Prof. Ewing. The idea of magnetic lag, quite apart from Foucault currents in the iron, was put forward some years ago in that room in the paper, prepared by himself and his colleague, on electro-motors and their government, and the conception was used in all the calculations they made. This conception was somewhat laughed at by writers in some standard books. Their names were held out to reproach as having brought forward an idea of a magnetic lag which was something different from a lag due to Foucault currents, and which could not be entirely removed by any amount of lamination. Now, however, that the Greek name *hysteresis* had been given to the lag, the classically-educated Englishman was willing to believe in it.

FIG. I

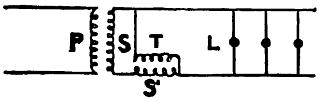

FIG. 1.—Ayrton and Perry's proposed self-regulating transformer for use with transformers in series on the main circuit. P. Primary coil, with constant (mean alternating) current. S. Secondary coil joined up to lamps L. S′T. Auxiliary regulating transformer, S′ the exciting coil in main secondary circuit, acting as primary to coil T. When the potential difference at the terminals of S falls off by reason of increase in the current through S, this increase of current passing through S′ excites a larger E.M.F. in T, which thus adds a potential difference to the lamp circuit, compensating for the falling off of the potential difference set up by the main secondary coil S alone.

He had spoken about wrong ways of making measurements of the efficiency and power given to transformers. Now he would say a word about the right ways of making such measurements. He was interested in doing this because, through the kindness of Mr. Kapp, who had lent him one of his transformers some time ago, a considerable number of experiments had been made by the third-year students at the Central Institution during the past few weeks. The students had worked at the subject with the most laudable perseverance, in spite of the very considerable number of difficulties which they had to overcome. There was only, as far as he knew, one electric method for measuring the power given to a circuit which contained self or mutual induction. The method was a method employing the quadrant electrometer. It was a method which Dr. Hopkinson employed in measuring the efficiency of Gaulard and Gibbs' transformers on the Underground Railway some few years ago. Let A B (Fig. 2) be the circuit possessing self or mutual induction, or both, the power given to which it is desired to measure. Place in series with this a *non inductive* resistance, B C, of known value r ohms, and send a current through the two by means of the dynamo A. Join the pairs of quadrants of an electrometer to the points A and B, and the needle to C; then if A, B, and C represent the potentials at any moment of the three points, and if D be the steady deflection of the electrometer

$$D=\frac{k}{2\tau}\int_0^{2\tau}(A-B)\left(C-\frac{A+B}{2}\right)dt,$$

where τ is the interval between two alternations. Next, join the needle to the point B, and let a steady deflection, d, of the electrometer be now obtained; then

$$d=\frac{k}{2\tau}\int_0^{2\tau}(A-B)\left(B-\frac{A+B}{2}\right)dt.$$

Consequently,

$$\frac{D-d}{rk}=\frac{1}{2\tau}\int_0^{2\tau}(A-B)\left(\frac{B-C}{r}\right)dt.$$

Now the expression on the right-hand side is the mean value of the true watts given to the circuit A B, therefore $\frac{D-d}{rk}$ measures this mean value of the true watts.

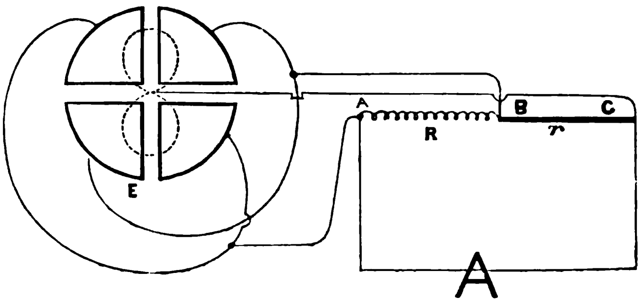

FIG. 2.—R. Inductive resistance to which power given by alternating current is to be measured. r. Inductive resistance. E. Electrometer. A. Alternating current dynamo.

It was rather interesting, because this method occurred simultaneously to Prof. Fitzgerald, of Dublin, and to the speaker during the Paris Electrical Congress of 1881, while listening to M. Joubert's paper on the measurement of alternating volts with an electrometer, which, of course, was a very much simpler thing. The use of the electrometer to measure volts only did what a Cardew voltmeter would do. The use of an electrometer to measure power, given by an alternating current to a circuit possessing self or mutual induction, did what no other instrument would do. But though the method was theoretically perfect, it had distinct practical objections. The first objection was that another resistance B C (Fig. 2) had to be put in series with the conductor A B, in which the power expended was to be measured, and, of course, a certain amount of power was wasted in this wire, B C. That did not interfere with the accuracy of the experiment in any way, but it might be inconvenient to have to waste any power in a circuit previously worked up to its limit. But there was another more serious objection which he was not aware of up to the last couple of years. Their formula was worked out on the assumption that the ordinary law of the electrometer, as given, for example, by Clerk Maxwell, was true. The law of the electrometer, as given by Clerk Maxwell, was that the deflection of the needle of an electrometer was proportional to the difference of potentials between the quadrants multiplied by a term containing the potential of the needle, minus half the sum of the potentials of the quadrants. Unfortunately, as experiments made at the Central Institution had shown, it was an exception for any given electrometer to satisfy this formula. He would not go more into that at the present time, because it would form the subject of a subsequent communication. He merely wished to warn any of them who were going to use the electrometer that, although this method was perfect on the assumption that the formula given in books was the formula for the electrometer, it naturally was not so perfect if the formula was wrong; so that even this method, pretty as it was, was at fault. Well, then, there was only one other method that he knew of by which they could measure the power and efficiency of a transformer, and that was the calorimetric method. They wanted to measure the power given to the transformer, and the power given out by the transformer. The power given out by the transformer could be easily measured. The secondary circuit would give current to, say, incandescent lamps, and as there was no lag in this part of the circuit the power could be measured merely with a voltmeter and dynamometer. But they could not employ that method to find the power given to the primary. They could, however, do it indirectly in this way:—Put the transformer in a calorimeter; first put it in a box, close it up water-tight, then put it in another box, which must be water-tight at the bottom, but need not be water-tight at the top; arrange a definite resistance in the secondary circuit, and send a definite current through the transformer for a certain time, and allow water to enter, say, at the bottom of the calorimeter and to flow out at the top, and measure the temperature of the entering water with a thermometer and the temperature of the water which leaves, and keep the current flowing until everything has become quite steady—until the temperature of the water as it flows out of the calorimeter ceases to rise, which in some case took as long as three and a half hours. Then, quite apart from the

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KAPP AND SNELL TRANSFORMER.

Experiments made at the Central Institution by Messrs. DYKES, LAMB, PRIEST, SMITH and ZINGLER.

Primary.		Secondary.		Calorimeter.	Watts given out by Secondary.	Watts given to Primary.			Efficiency.		
a Volts.	*b* Amperes.	*d* Volts.	*f* Amperes.	*g* Watts wasted in Heat.	$h = \sqrt{d^2 \times f^2}$	$g + h$ True.	$\sqrt{a^2 \times b^2}$	*j* by Wattmeter.	$\frac{100\,h}{g \times h}$ True.	$\frac{100\,h}{\sqrt{a^2 \times b^2}}$	$\frac{100\,h}{j}$
184·3	0·8	94·5	0	53·18	0	53·18	147·2	98·5	0	0	0
184·6	2·3	96·8	3·3	79·05	318·7	397·8	424·5	446·7	80·1	75·1	71·4
187·6	3·32	97·7	5·09	82·63	495·6	577·9	623·7	653·2	85·8	79·5	75·9
186·1	8·31	94·3	14·87	55·6	1416	1472	1546	1727	96·2	91·5	82
185·6	16·14	91·44	30·59	149·9	2813	2963	2995	3277	95·0	93·9	85·9

Each test given in the above table is the mean of five or six consistent results.

Efficiency $\frac{100\,h}{\sqrt{a^2 \times b^2}}$ neglects the lag due to the self and mutual induction of the transformer.

Efficiency $\frac{100\,h}{j}$ neglects the lag due to the self and mutual induction of the transformer; also the lag in the fine wire coil of the watt meter due to its self induction.

Time of an alternation in all the experiments was about $\frac{1}{180}$th of a second.

specific heat of the transformer and the calorimeter, and so on, they had at once the power wasted in the transformer. Supposing W was the weight of water in grammes which flowed out of the calorimeter in a time of, say, *t* seconds, and suppose T was the difference of temperature between the entering water and the leaving water, which he had supposed to have become quite steady, then the power in watts wasted in the transformer and given out in the form of heat was equal to W, the number of grammes of water, multiplied by difference of temperature T divided by the time in seconds *t* into a constant ·239. That gave them the power in watts that was wasted in the transformer. That added, of course, to the power given out by the secondary, which was obtained by electrical measurement, gave them the power put into the primary, and they had then the whole measurement with a considerable amount of accuracy. Let him repeat, power given out by the secondary was accurately measured, provided that the secondary was attached to incandescent lamps or to something having no self-induction nor mutual induction, by the square root of the mean square of the volts multiplied by the square root of the mean square of the current; that was to say, measured by the reading of the Cardew voltmeter multiplied by the reading of the Siemens dynamometer. That was the power given out in watts. The power wasted was measured by the formula already given. The ratio of the watts obtained in secondary to the sum of the two is, of course, the efficiency. Well, that method had given them very fair results. He had compared these readings with those obtained by putting a dynamometer and a voltmeter on the primary circuit. For the interest of the thing, they had also an ordinary wattmeter in circuit, the thick coil in series with the primary and the fine coil a shunt to the mains. Now, it was interesting to see the sort of results that were obtained on the different systems of measurement, especially as they knew which results were true and which results were more or less correct. In the first case, the circuit outside was broken. That is, there was no current in the secondary circuit. This particular transformer was an exact *fac simile* of a small transformer which Mr. Kapp had on the table last time. He might mention that Mr. Kapp's mode of rating transformers was an extremely satisfactory one. Very often when a new apparatus was devised the nominal power was stated in excess of what the real power was. But transformers, at any rate Messrs. Kapp and Snell's transformers, were on a par with the steam engine, and that was that the real power developed was far greater than the nominal. He did not know whether his dynamos were equally good; but if so they must be extremely good. This was the two horse-power transformer nominal, which did not mean, he was happy to say, that it gave one horse-power. It meant that you could get three out of it, or even four without undue heating (applause). In the first case the volts at the primary circuit were 184·3, the volts at the secondary—the circuit being open—were 94·5. Now let them see the enormous differences of the power as measured in the different ways. The watts put in as measured by the voltmeter and dynamometer were 147. The watts put in measured by the wattmeter were 98·5. But the actual power put into the whole circuit was only 53 watts. Therefore the two first were enormously too large; and they could see why they were too large. They were too large because, when the secondary circuit was broken, the effective self-induction of the primary coil of the transformer was very much larger than when the secondary circuit was closed, and the errors of both methods became immensely magnified. Of course, in this case, since the secondary was open, all the power put in was wasted in the heat. But the real watts given to the primary, as determined by the calorimeter, was 53·2. The other methods indicated, then, about from two to three times too much. Of course, as the secondary circuit was closed and less and less resistance was put in, the readings given by the wattmeter as well as the product of indications of the voltmeter and dynamometer became nearly equal to the true watts, but they never, even for the maximum power, became equal. For example, when 2,963 watts were actually being given to the transformer, which was about 4 horse-power, the product of the square root of mean square of volts into square root of mean square of amperes gave 2,995 watts, while the wattmeter gave 3,277 watts as the power put into the transformer. The readings obtained from the voltmeter and the dynamometer were higher than the true watts put in, because lag, due to the self and mutual induction of the transformer, was ignored altogether. The wattmeter readings were higher than the true watts put in, because, not merely was the lag due to the self and mutual induction of the transformer neglected, but the lag in the fine wire coil of the wattmeter, due to its self-induction, was also ignored. That led him to investigate the question as to whether the wattmeter ought to give them an answer nearer the truth than the product of V squared into C squared; and the result that he had obtained, approximately at any rate, was this:—The wattmeter might or might not apparently give them an answer nearer or farther away from the truth than the reading from the dynamometer and the voltmeter. A rough calculation showed this was what was obtained with a wattmeter. Take a wattmeter like a Siemens wattmeter, which had practically no mutual induction, but had some self-induction; then if such a wattmeter were employed to measure power in a circuit having self-induction this seemed to him what would be obtained. If τ was the time of an alternation, r the resistance, and L the coefficient of self-induction of the fine wire circuit of the wattmeter, r' and L' the resistance and self-induction of the circuit the power given to which it was desired to measure, then the reading of the wattmeter, compared with the true power which they wanted to measure, had this value $\frac{r}{r'} \times \frac{\tau^2 r\, r' + \pi^2 L\, L'}{\tau^2 r'^2 + \pi^2 L^2}$. It was possible, by putting but a few convolutions on the suspended fine wire coil of the wattmeter, and using for the greater part of the resistance of the fine wire circuit a stationary non-inductive resistance, to make L the coefficient of self-induction of the fine wire circuit of the wattmeter very small, but unless it were made absolutely nought, the term $\pi^2 L\, L'$ might be large in consequence of the largeness of L, and the expression would be the greater the greater L' was. So that, in other words, they might expect when the circuit the power given to which they wished to measure had very much self-induction, that the wattmeter would give an answer far too high. In the wattmeter used at the Central Institution, the self-induction of the fine-wire circuit was made very small in the way just indicated, the resistance of the suspended coil having only $\frac{1}{150}$th of the value of that of the non-inductive stationary coil, but still the watts given to the primary as measured by the wattmeter were 200 per cent. too large when the secondary circuit was open.

Captain CARDEW said: He thought Mr. Kapp's paper would be generally considered a valuable addition to the rather meagre information which at present they had on the subject. The chief theoretical novelty in this paper was the method given of making allowance for the power lost in heating iron core, the difficulty of which was that this loss of power affected to some extent the angles of lag, and unless they could allow for this the electrical power supplied could not be exactly computed except, perhaps, by watt-meter. He did not feel quite happy about Mr. Kapp's solution. The assumption was that hysteresis produced an inductive effect always additive to that in the secondary coil, and if there were a true molecular friction this might be the case; but surely this was not the whole of the molecular forces, and the molecular forces as a whole opposed magnetisation and helped demagnetisation, while the friction alone opposed change of magnetisation. His ideas were probably very crude; but he looked upon a molecule of iron under cyclic changes of magnetisation as a straight spring bent first one way and then the other out of its natural position. When you bent it, there was opposing force; most of the energy was stored up and given out as the spring returned, but some was lost in friction. He was going to show his idea of the curve of magnetisation. Although the molecular resistance, apart from friction, might not expend energy, it might alter the curves and lags at different points. As it was the rate of change of magnetisation as a whole, which affected the secondary current, he did not see how they were to separate the frictional effect from the force opposing magnetisation and helping demagnetisation, which at one part of the curve acts with the friction, and, with the secondary current to oppose magnetisation, and, at another part acts against it. The risk to life from the use of the alternate transformer system had been the subject of anxious consideration, and apart from any question

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of Government interference ; it was certain that any serious accident would materially check the progress of the system. The risk could not be considered chimerical. They had in a transformer two conductors laid in close contact with each other, and with an iron core, and they were necessarily thinly insulated. One of these conductors might acquire at times any potential difference up to 2,000 or up to 2,400 volts over the other. He need not point out to this meeting that in the primary circuit, taken as a whole, there was certain to be a resultant leak. The other conductor had also its resultant leak, and this was likely to offer a resistance of not many thousand ohms. They had here what would be recognised by all who had worked much as cables and condensers, conditions favourable to an eventual breakdowns Seeing the obvious importance of some safeguard, he had waited in vain for its being brought forward, and he eventually attempted a solution himself, with a result they saw here—[pointing to an exhibit]. This iron box was a trap for leakage. This piece of aluminium foil—not platinum, as Mr. Kapp said—the lightest, not the heaviest metal—is what they might call the bait. It consisted of two round discs, separated by a narrower portion. This was laid flat in a shallow depression in the bottom of the box, which prevented any lateral displacement. There was also an insulated disc, which was just over the aluminium, and it was connected to a piece of very fine wire, which supported a spring. The box was connected to earth. The distance of the insulated disc could be adjusted by means of a screw. There was also a little disc which told them the distance at which the insulated disc was above the aluminium foil. This insulated disc was connected to any point on the secondary circuit through that piece of fine wire. Should the secondary circuit ever acquire a potential differing from the earth by more than whatever volts the safety device was set for—anything from 500 upwards—the aluminium foil was drawn up by the ordinary static attraction until it was in contact with the disc attached to the fine wire. The instant it was in contact with the disc of course it was repelled, but while in contact it had completed the circuit, and an arc would follow it, which, of course, quite instantaneously fuses the fine wire. As soon as the fine wire was fused, down came that spring and short-circuited the primary circuit, causing the double pole cut-outs to operate. He had here one of those little foils which had been used several times over. It was so little injured that it had been used again and again. It had stood an alternating potential of 2,400 volts. Prof. Ayrton suggested these things were not necessary, because it was so easy to connect a secondary circuit to earth. That, of course, had occurred to a great many people. If they connected the secondary circuit to earth, at any rate it was all right for the customer. But putting the secondary circuit to earth insured that, as far as the secondary circuit went, there was no insulation, and consequently it practically did very much increase the strain on the insulation between the primary and the secondary circuit. Mr. Kapp described another device which had the same objects ; he would only say, as a customer, he should be quite satisfied with it. As a maker of transformers, he should take it as a boon, because he should expect there would be a considerable demand for transformers. As a supplier of light, he should rather object to it.

Mr. A. Bernstein said that in addition to the very excellent paper of Mr. Kapp, and the interesting remarks of Mr. Mackenzie, they had another paper that evening by Prof. Ayrton, "On the theory of Secondary Generators," for which they were all very thankful. Under these circumstances, there was rather an *embarras des richesses* of questions upon which one might be induced to enter. He would confine himself to a very few, and those only in which he felt naturally most interested. One of these questions was that of putting transformers either in series or in parallel. Mr. Kapp had already said that where light was to be distributed from stations over a very large area it might be advantageous to put the transformers in series ; but in relation to that he should like to call attention to some very important facts. In a system of transformers, where they used high-tension alternating currents, the question of insulation became a very serious one, as they had just heard from Captain Cardew. If they used transformers in parallel, they were obliged to use two main conductors between which there was a very high difference of potential, say 2,000 volts, and they were, further, obliged to put them very close to each other in order to prevent induction on other wires. This made the insulation exceedingly difficult. Where they had transformers in series they only had the highest difference of potential at the dynamo end of the circuit, and they reduced the difference of potential constantly on their line, so that the mean difference of potential was only one half as much, and from the theoretical point of view one would say the tendency to produce a leak would only be a quarter as large. This, of course, was a very serious matter in the insulation of these conductors, but in addition to this the matter became of far more importance, even in the transformer itself. In a transformer on a parallel system they had the same mean difference of potential of 2,000 volts between the ends of the coil, and as they could not use very heavy insulation in these coils if they wanted to have an efficient transformer, there was only a certain liability of leakage taking place. In a series transformer this difference of potential might be reduced to 50 volts or 100 volts, or just according to circumstances, and that enormously reduced the tendency to produce any leakage. Those were two very important advantages which the series system had over the parallel system, and they were so very important, as he said before, because the question of insulation in a transformer system was one which offered a good deal of difficulty. There was another question which he should like to ask Mr. Kapp. They had been told repeatedly, although there was hardly any distinct statement made in regard to the matter, that although the efficiency of the transformer is very high when the maximum amount of power is used, it is considerably reduced when the number of lights is decreased. He did not see why it should be so very considerably reduced, but the statement had been made. Anyhow he was inclined to think in this respect, too, the series transformer would offer an advantage over the parallel transformer. That was a matter on which he would be glad to have some information from Mr. Kapp in his reply. He would now turn to another point. That was the device to prevent the current going from the primary into the secondary. First of all they would see at once that where there was a tendency to short-circuit the primary with two thousand volts, there was a tendency to heating. That destroyed the insulating material between the primary and the secondary, and there was a leak. The device of Mr. Kent might work very well, but it might, at the same time, do a great deal of harm if proper precautions was not taken. There was such a thing as leading an electric current into temptation ; that is to say, if they gave an electric current a chance to go to the ground and find another way it would surely do so. He would illustrate that by an example. There were in the United States a very large number of arc light circuits several miles in length of overhead wire. After these had been introduced, it was considered advisable to put lightning arresters on these circuits, and the curious observation was made that while formerly it was a rare case that the lightning should take its way through the wire, as soon as the lightning arresters were put on it occurred very frequently. Those lightning arresters, in fact, acted, to a certain extent, as lightning inducers, and the remedy was only found by very much increasing the distance between the plates, so as to give the current from the lightning more resistance. In using such devices as that of Mr. Kent proper precautions must be taken not to give the current a chance to leak from the primary into the metal plate, and from there into the earth. Prof. Ayrton had mentioned another device which consisted in connecting the secondary to earth. With regard to these matters, he should like to mention something on behalf of Prof. Forbes, as that gentleman was not then present. When he first showed some members of this society his contact plug used in his system of series lighting, with which he supposed they were sufficiently familiar, Prof. Forbes at once made the remark that this contact plug would work exceedingly well to protect the secondary line by making a connection to earth, because the principle of the contact plug was this:—That as long as the difference of potential between the line and the earth was a normal one, there was hardly any perceptible current going away, and it might be made very high, 2,000 ohms or 5,000 ohms, if they wished ; but whenever this difference of potential increased, which would be the cause of the leak from the primary to the secondary, then that contact would at once make a short circuit. That, he thought, was a very ingenious idea of Prof. Forbes, and he considered it preferable to seeing it dragged to earth as suggested by Prof. Ayrton. He only wished to add in regard to Mr. Mackenzie's paper that he fully agreed in one of the observations which that gentleman made, and that was that they should never put the electric light on to gas fittings, especially in systems in which the high-tension current was used. It was an enormous mistake to do so, and it always led to faults. In America, to his knowledge, it was distinctly prohibited wherever high-tension currents came into play. He heard from some gentlemen connected with the Edison Company that, even with low-tension currents, they did not like it. He himself thought it was an altogether bad practice. It was a practice which was only resorted to to make things cheap, but it was certainly one which ought to be abandoned.

Mr. Atkinson (of Halifax) said the few remarks that he would make referred principally to Mr. Mackenzie's paper. Mr. Mackenzie said that the great improvement of the last year or so had been the introduction of iron into the armature. He quite agreed with Mr. Mackenzie that the introduction of iron had been a great advance, but the mistake seemed to have been made of attempting to work the iron to the same degree of saturation as had been attempted in direct-current machines. The builders of the multipolar disc dynamos had found by experience that with more than six poles, at all events, there was great difficulty in keeping down the heating of the iron in the armature, however well it might be laminated. A short time ago he roughly made a calculation (taking that as a basis) of how many lines of force they might take in an alternate current machine without danger of heating from magnetic hysteresis. Thus assuming that a six-pole machine running at 600 revolutions with (taking Mr. Kapp's system of figures) about fourteen lines to the square inch, which he believed was about the maximum, they could work a machine of that size and speed, then with a sixteen-pole alternating machine at the same speed, and assuming there to be no greater hysteresis from viscosity, they could not use more than about nine lines to the square inch to produce the same amount of heat. That pointed at once to a considerable reduction in the density of magnetic lines to be used in alternate current machines. In the machine which Mr. Mackenzie had described he placed alternately coils on primary circuits separately excited, and similar coils differently wound formed an alternating circuit. Now it appeared to himself that on working this there would be produced equally in both of those coils an alternating electromotive force, and therefore unless the machine was excited by a series dynamo, or some dynamo with considerable self-induction about it, there would be a very large alternation in the exciting circuit, and as, generally speaking, continuous-current dynamos were not constructed to stand that, it would produce rather a curious effect. He did not know whether Mr. Mackenzie had practically discovered that, or whether he had had any practical difficulty from that fact. He (the speaker) had brought there (it was hung upon the wall) a photograph of the Connaught dynamo, designed by Mr. Kapp, and constructed by Messrs. Goolden and Co., for producing alternate currents, which had iron in the armature. That particular machine was for 2,000 volts, 30 amperes, and 600 revolutions, and weighed 2½ tons, which was about 90lb. to the unit, which was a pretty fair result. The armature was a large hub of cast iron or steel, on the rim of which was wound iron tape. On the other side of that was carried an iron wire—that is, because the magnets came over the

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top so as to laminate in all directions at right angles to the lines of the core, which was all securely riveted through, and they would see, coming through the hole there, driving spurs round the wire. The magnet ring was 40in. in diameter. There were 16 pairs of poles, and the speed at which it ran was 600 revolutions. That the thing was mechanically good was shown by this fact, that when it was running at about 1,500 volts, and at its full speed, it was accidentally short-circuited, which pulled up the engine and gave the engine a considerable shock; but there was no damage done to the armature, and no wire shifted in the slightest degree. That was a pretty severe test, because the armature had a very low self-induction. Mr. Kingdon called attention to his machine as possessing this advantage, that he could attach those inductors direct to the fly-wheel of an engine. He himself did not know what Mr. Mackenzie's experience with the owners of engines was, but he thought for one owner whom he would get to allow him to attach this kind of thing to the fly-wheel he would get about a hundred who would put on a pulley and would drive a machine that was going at another speed and could be conveniently put at any place they required. Moreover, he himself admitted the advantage of using a larger number of small machines rather than one very large machine, which, in the case of a breakdown, would totally collapse. Further, a good deal had been made of the point that in machines of the class shown on the wall, what they might term the armature circuit (that is, the circuit which produced the current) was not moving, and that, therefore, the circuits might be coupled in parallel or series, as the case might be. He did not think anybody would attempt to alter the coupling of a machine of that kind giving 2,000 volts while it was running. Generally speaking it was only for experimental purposes that a machine of that kind was required. People knew beforehand what they wanted, and they ordered it, and having got a machine to do the work they required, they did not want to alter it when it was running, so that he thought there was really very little upon that point. The only other point he would refer to was the remark of Prof. Ayrton as to the series compound-winding of transformers. He understood Prof. Ayrton to admit that he had not gone very far into the subject. He himself had devoted some little time to consider it. He regretted that he could only speak now from memory. He had come to the conclusion that somewhere or other there was a nigger in it. He could not see how the result is to be produced. In the diagram Prof. Ayrton gave, if he did not misunderstand that gentleman's meaning, he showed a coil placed in parallel with the main coil, and drew the analogy with a compound-wound dynamo. Now, it seemed they could not raise the volts on the terminals by putting one coil parallel with another unless that other coil was going to supply the whole circuit; that was to say, if that coil would produce more volts than the other coil, well, it would at once begin to work back through the other coil. Perhaps, however, he misunderstood Prof. Ayrton; but he was inclined to think from having considered it rather carefully that the compound winding of transformers could not be done.

Prof. AYRTON (describing on the blackboard) said that if they put two cells in parallel without one having higher volts than the other they got a higher difference of potential at the terminals; it was the simplest experiment in the world.

Mr. ATKINSON said that result was only produced by reducing the output of the original cell—that is to say, practically substituting the second cell for the original one, and if the original one was still doing its same work the electromotive force at the terminals of that cell would remain as before.

Prof. FLEMING said that he should like to describe some experiments that he made in 1885 in a couple of Zipernowski transformers, which were brought over and exhibited at the Inventions Exhibition. In that year Mr. Zipernowski brought over two of his now well-known lifebuoy-shaped transformers, and he placed them in the Inventions Exhibition, and he took the opportunity to make some experiments upon those transformers. He might mention that the transformers were wound in order to be arranged in parallel, and that they were worked from a self-exciting alternating current machine at some distance away, and in order to give the opportunity of seeing how this system adapted itself to the transmission of energy over great distances they placed the alternate current machine as far apart from the transformers as convenience would permit, and he believed that those transformers were a thousand feet away from the alternate current machine. Each of those transformers was intended to work a full load of two hundred 16-candle lamps, and they were connected by a No. 10 wire with the machine. He might mention that the primary current was operated by an electromotive force of about 1,000 volts. At that time Dr. Hopkinson had just drawn attention to some possible danger that might result from electrostatic capacity on the part of the transformers used, and it immediately occurred to the speaker, as it did to others at the same time, that that difficulty might be remedied or diminished by connecting the secondary circuit to the earth, and in these transformers exhibited in 1885 the secondary circuit was connected to an earth-plate. On mentioning this Prof. Elihu Thomson, of America, wrote to one of the technical journals to say that he had suggested that method before, and thereupon Profs. Ayrton and Perry wrote also to the same journal to say that they had suggested it before Prof. Elihu Thomson, and there the matter rested. He might also mention as an interesting fact in connection with these transformers that Mr. Zipernowski had arranged a method of self-regulation which was not very unlike that which had been sketched on the board by Prof. Ayrton. He could not for the moment trust his memory for the exact details of the method, but it would be found in one of Mr. Zipernowski's specifications for the year 1885. The principle of that method was the use of an additional transformer, which was so arranged that when the terminal volts at the main transformers were lowered this additional transformer raised them again, or tended to raise them again, to the normal value.

Prof. AYRTON said that he had mentioned the names of Gaulard and Gibbs, but he expected that it was Zipernowski. He should like to know whether it answered fairly satisfactorily.

Prof. FLEMING was understood to reply that he thought it did. He went on to say that then their attention was naturally directed to some method of determining the efficiencies of these transformers. They knew at the time of the quadrant electrometer method, but they had not got a quadrant electrometer. Mr. Zipernowski had brought over with him a couple of large wattmeters which he had constructed, from which they thought it might be possible to get some results tolerably trustworthy. The wattmeters were like the Siemens wattmeters, but they were made very large, and the intention was to make the induction of the fine wire as small as it could possibly be made. For that purpose the movable frames were made very large, and the whole of the fine wire resistance was not put into the movable frame. Fine wire resistances were placed outside the movable frame in the form of a non-inductive resistance in series with it; and the actual moving frame or the voltmeter part of the wattmeter consisted of a comparatively few number of turns forming a large rectangular frame, and if he recollected rightly these wattmeters stood some 2ft. high. In these instruments in the position in which the reading was taken there was no induction between the fine wire and thick wire circuits. Provided with a couple of these instruments, one of them placed in the primary circuit and the other in the secondary circuit, they made some measurements which they hoped would give them something approximating to the efficiency of the transformers at various lamp loads. [The results obtained were shown in a diagram exhibited.] It was obvious, of course, from what Prof. Ayrton had said, that those numbers could not be correct. But it would be very interesting now with the apparatus designed and worked by Prof. Ayrton to ascertain how far readings taken with the wattmeter built on this plan did give discrepancies between the real percentage of the transformer and that obtained in this way. It was very important that attention should be paid in connection with transformers to the question of the actual magnetic lag. There was no question that magnetic lag was a reality, and that there was a lagging behind in the time in which iron reached its maximum magnetisation as compared with the time at which the magnetising force came to a maximum. It followed from that that they would have to modify the method of treating the magnetic resistance of magnetic circuits in a manner analogous to that in which they had to modify the resistance of electric circuits when they were dealing with alternate electromotive force. They knew perfectly well that they had to bear in mind—and he would impress this upon beginners—that they did not and could not obtain the average current in a circuit working under an alternating impressed electromotive force by dividing the average value of the impressed electromotive force by the resistance of that circuit. But they would have to consider the resistance instead of that quality, which had been properly called by Mr. Oliver Heaviside the impedance. The impedance was a quantity which took into account the quality of the conductor, in virtue of which there was a lag of current behind the electromotive force; therefore, in dealing with the question of magnetisation, it would follow that in the case of magnetic lag in magnetic circuits they must substitute for magnetic resistance a quantity which might be called the magnetic impedance of the circuit. The theory of the transformer was in one respect simpler than that of the dynamo, because they had no air gap to consider, and they had in properly designed transformers no waste field. The undetermined quantity which appeared in all the theoretical investigations at present published on the theory of the transformer was the magnetic resistance term; and it was necessary that special experiments should be made in order to ascertain what were the values of the magnetic resistance corresponding to the same magnetising forces only operating under different periodicities. The experiments which he should like to see carried out on this subject would be the effort to obtain what might be called the permeability curve of iron under alternating magnetising forces when they were working with the same average magnetising force, but operated at very different periodicities. With regard to the question of safety it could not be doubted that in the course of time very many different devices would be designed for attaining security and preventing the electromotive force from the primary circuit getting into the secondary circuit. It would no doubt be possible to arrange something on a plan which would be tolerably simple, and yet, perhaps, work effectively.

The speaker concluded by sketching on the blackboard a form of automatic cut-out for separating off the secondary circuit in case of a rise of E.M.F. in the secondary much above its normal amount.

Prof. AYRTON said that he now recollected that there was a Zipernowski wattmeter that he had used. It was made exactly in the way Prof. Fleming described, and it gave an error of 300 per cent. The greater part of the resistance was non-inductive. There was a separate resistance box; the fine wire coil was fairly large, with comparatively few convolutions.

Mr. CROMPTON said he should like to say a great deal upon this subject were it not for the lateness of the hour. He would not go in much for mathematics in what he was going to say, but he thought his remarks would interest some members, because he proposed to tackle this question from a commercial point of view. In order to do that he was proposing to catechise Mr. Mackenzie on two or three most important points, and he should be much obliged if that gentleman would come prepared to answer those points at the next meeting. Mr. Mackenzie had been the engineer to the Grosvenor Gallery installation, and had had close connection with some of the large commercial enterprises that had been using alternate transformers, and he would like to know if he would give to the society certain information as to the actual efficiency of this system. They had heard a great deal of the efficiency of transformers, and they had heard a great deal of the efficiency of dynamos and the steam engines that drove them. He himself was prepared to give the efficiency of other systems

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right out, from the coal bills to the electricity sold to the consumers, and he wanted Mr. Mackenzie to do the same. Then he proposed to compare the two systems together, and then they would begin to know what it all meant, and whether these high efficiencies claimed for these transformers, when the transformers were worked to their full capacity, could actually be measured when they were worked at very low capacity. That was the most important part of the whole subject, and it really affected them commercially more than anything else.

The CHAIRMAN announced that the discussion would be continued on Thursday, the 23rd inst., and the proceedings terminated.

INSTITUTION OF MECHANICAL ENGINEERS.

DISCUSSION ON MR. GEIPEL'S PAPER, "ON THE POSITION AND PROSPECTS OF ELECTRICITY AS APPLIED TO ENGINEERING."

Mr. J. FEARFIELD, Stapleford, Nottinghamshire, opened the discussion. He said that the question of electrical engineering was coming up before the whole of the members of the Institution as the coming trade of this country. The author said that "were it not for the cost of the dynamos and motors electricity would supersede, to a great extent, the use of belts and shafting," and he (the speaker) should like to tack at the end of that "were it not for the cost of the brushes and commutators and the armatures." He had put several dynamos down by one of the best makers in England, and he found with some ten or eleven now running that, even with good ordinary engine drivers, who had been fairly trained to the work—not electrically trained—there was not the knowledge which it was desirable to have. The armatures were often wearing down. He had four of them running in his own works and eight or nine in other works, and he found that the repair of armatures ranged from £4 up to £7 and £8, and in one instance £10 per annum, the armature only costing £18 in the first instance; and it was caused by the wearing down of the phosphor-bronze commutator, which, if oiled too much, forced from the brushes, and the electrical current cut the barrel of the commutator irregularly; and, therefore, they were forced to put it in again and true it up, or else they would find the engine-driver run it dry, and the brushes, whether they were wire or split plate brushes, cut it at once, and the copper dust got inside their work. When they sent the armature to be repaired they found the insulation was gone in several sections, and it had to be rewound. He was merely mentioning this fact from his own experience, for, unfortunately, he had had to put several of these armatures down, and this was an item of expense; and this applied not only to transmission of power but also to electric lighting. With regard to the cost of the electric light, he had had a good deal to do with electrical transmission and with electric lighting, and he found that it varied very much. In a small plant he had put down it could not be kept, under the most favourable conditions, under seven shillings per thousand cubic feet. The Nottingham Corporation supplied them with gas at a distance of nearly eight miles from Nottingham for 2s. 4d. per thousand cubic feet, and with the electric light, extending over a period of four years, it had practically cost them 2s. 1d. per thousand cubic feet. That was with an equal light. Now, some people expected to get from the electric light ten times the amount of light that they got from gas, but they placed no value whatever upon the consideration that the electric light gave them a purer light than gas, a far better atmosphere and no dirt. In one case, where there were over 90 girls at work, the factory inspector congratulated his father upon having the electric light put in because of the difference it made in the health of the girls. Then the person for whom he had done this work congratulated them upon the absence of dust upon his lace, and therefore a saving from the cost of the spoilt stock. In the almost immediate future engineers would have to deal with the electric light and the electric transmission question together. With regard to their being easily fixed and as to conductors, there was a party given at a place close to their works, and they wanted a few lights up in front of their house. He sent two men—one was a fitter and the other was a man who attended to the dynamos—to do the work. They were back again at the works in two hours, having placed twenty-four lights in the gardens in front of the house. The lights worked for two nights, and they were taken down again in an hour and a-half. He drew attention to that point to show that the electric light could be fixed far easier than any other light.

The PRESIDENT: Would you kindly tell us what the cost of your gas was, and would you compare that with the cost of your electric light?

Mr. FEARFIELD said that where the Nottingham Corporation delivered—and they delivered on several radii within eight miles of their gas works, —they delivered at 2s. 4d. per thousand cubic feet. Compare that with one small installation that only drove 30 or 40 lights—in a factory which had steam in the boilers at 95lb. pressure day and night (Sundays included)—it would cost, including repairs, pretty nearly 7s. per thousand, and it would cost to put the same light in with gas 7s. per thousand cubic feet. In the most favourable installation of which he had any knowledge the electric light cost, in comparison with gas, about 2s. 1d. per thousand cubic feet.

The PRESIDENT: The same candle power?

Mr. FEARFIELD: Yes. For the same absolute light that I get scattered over those works I should have to pay 2s. 4d. per thousand, and I only pay by the electric light 2s. 1d. per thousand for the same light. In the other instance, that of the Limited Company, they pay an equivalent of nearly 7s. per thousand cubic feet. If they were to put gas on, to get the same amount of light, they would have to pay 7s. for it. In the one case the electric light cost something like 30 per cent. less than gas, cheap as it is; in the other case it costs about 300 per cent. more. It is simply a question of the size of the light; it is a question of the convenience of the engine, the convenience of the driving, and the size of the plant. In one case it is running 55, at the most 60, lamps of 16 candle-power, and in the other it is running 300 lamps of 18 to 20 candle-power. It is a 500-light installation really, but I never have more than 400 lights running at once.

The PRESIDENT: Are we to understand that you mean a larger installation costs you more than a smaller installation?

Mr. FEARFIELD: No, I beg your pardon; the larger the installation the less the cost will be.

The discussion was then adjourned until the following evening.

DISCUSSION RESUMED.

The discussion was resumed on Friday evening, when Mr. Carbutt occupied the chair.

Letters were read from Messrs. Henry Barcroft, A. P. Snell, Sydney F. Walker, A. S. Bolton, and Mr. Thomas Urquhart, of Borisogeluck, Russia.

Mr. SCHOOLBRED said that he quite agreed with Mr. Geipel that although electric lighting was a branch that had received by far the largest attention, in the approximate future the motive power would certainly receive great industrial application, and probably a very much larger amount of current would be used in that direction than in lighting, inasmuch as numbers of small industries would make use of such a cheap and cleanly mode of getting motor power throughout the entire day. Electric lighting had been produced on such a very small scale—in fact, an experimental scale—that it was out of reason to compare it with gas, which was produced on a scale hundreds and thousands of times larger than electricity; but he thought there was very little doubt that even gas engineers themselves would admit that with equal rates of production electricity was cheaper than gas. To his mind the future of electric lighting lay very much larger in the use of central station lines, which were just beginning at the present time. They would enormously reduce the cost of the supply of electricity. It stood to reason that where all the various establishments that were at present detached all over a town were concentrated in one central establishment the current could be produced at a very much cheaper rate. It appeared to him that in many cases, especially where public authorities supplied the current, they had no right to limit its use simply to lighting. Even commercially it would be found that the motor power would be largely used. He did not think it would be very long before people would discover that alternate currents in applications of that kind were not those which were suited for general use. Mr. Geipel had referred to the cost of the lighting at Messrs. Jaegers' sugar factory at Leith. He (Mr. Schoolbred) would refer to Messrs. Tait's sugar works in the east of London. There the installation was put up eight years ago. They began with arc lights, but eventually, when incandescent lighting came to the front, they adopted it, and they had now extinguished the whole of the gas lights in the place, although they were close to the Beckton Gas Work. They employed there 1,000 men, and so satisfied were they that electricity was cheaper than gas that they had used it in another establishment in Liverpool where they employ a similar number of men.

Mr. VOLK, of Brighton, said the mechanical engineers seemed to look upon electricity as though it was some formidable rival; but he wished they would regard it purely as a means of transmitting force from place to place. The manufacture of the dynamo and the motor was purely a mechanical undertaking. Electricity would run a heavy train up very steep gradients. The circuit of any given line would represent a number of beads on a string, circulating up one line and down the other. The carriages or beads would not all be taking the gradient at once, and the cars running down gave a certain amount of power to the line. There was practically an electrical balance maintained between all the cars on the track. His cars were hung on some little stirrup irons three or four inches clear of the roadway. There was no box or protection round them. The salt air and spray could flow straight under the car, and had free access to the motor. The motors had run from April, 1884, to the present time, and new brushes had only been put on them once. Those were only put in last year, so that the motors had run three years with one set of brushes. Where a motor was put into a box and the brushes were carefully attended to, the wear and tear would be nothing at all, and 10 per cent. would amply cover all depreciations, renewals and current repairs. He had taken the actual figures of his working expenses during the past four years, including gas, oil and waste. These items amounted to £430. 13s. 7d.; the repairs, the refacing the slides of the gas engine, and a little asbestos packing, amounted to £16. 7s. 5d.; the repairs to two dynamos and two motors, £64. 5s. 6d. After all, that money was spent in re-winding the armature, because one Bank Holiday a car was so heavily laden that it simply could not start at all, and the armature gave way. The working expenses were therefore only £32. These figures included everything that he had paid. He had put 10 per cent. per annum to the reserve and the average interest in addition was 13½ per cent. £509 had also been paid for damages. He took the mileage of the cars at 94,000 for the four years. That was only reckoning the mileage of one car, though two were run in the summer. The result was—gas, oil, and waste, 1·02d.; repairs to engines, ·04d.; repairs to dynamo and motors, ·16d.; wages, ·7d.; total, 2·1d. per car mile. That was not an imaginary reckoning up; it was the actual result of four years' working, and if any gentleman present was sufficiently interested in it and liked to bring down an accountant he would let him go through the books and show him all the vouchers. In his small way he thought he had fairly thrashed out the subject of electricity for light railways, and he hoped

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that others would take up the matter of accumulator cars. His line was rather under a mile in length, with some very steep gradients on it, and at first he tried some differential clutch gear for climbing the gradients, one of which was 1 in 25. He found, however, that the cars could do without the gear, and therefore he had taken it off. At first he tried 4in. leather belting, but he had now adopted link belting, which he put on in 1884, and it was still running, and he hoped it would carry them through next summer. In speaking of the succession of cars passing up and down the line he did not mean that they should be sent without any conductors or drivers. Reasonable care must be taken to keep the cars a proper distance apart. He had found no difficulty in working them in parallel; each seemed to take its fair share of current. He had only had three working at a time, and so long as sufficient care was taken they were perfectly under control. The driver would control the speed of the car.

Mr. Holroyd Smith said the paper as a whole was merely a summary of what had been done nearly all the world over, and he thought the mechanical engineers met together in that Institution to assist one another in inquiring into the "why" and "how" of things. In Mr. Geipel's paper there was comparatively nothing of the "why" and "how" relative to the various matters he had mentioned. Mr. Geipel had mentioned in his paper Dr. Benardos' and Elihu Thomson's methods. Those who had had experience with welding would predict that Dr. Benardos' system of using the intense heat that was incident to an arc of electricity was out of the question for producing a solid weld. The surfaces of the plates were simply fused together, and it was not welding at all. He ventured (though he might be laughed at) to predict that Dr. Benardos' process of attempting to weld iron together by means of an arc of electricity would prove an absolute failure. On the contrary, the method adopted by Elihu Thomson in his works near Boston was one that had the elements of success in it. He held in his hand some specimens that had been produced by it. One was a fine wire of copper, which he himself saw welded, and it would be found very difficult to break it at the weld. He had also a bar of copper and a bar of iron welded by the same method. A large current of the electricity was brought to the clips that touched the iron, and then the ends of the iron were touched together, the current was turned on, and they gradually got warm, and reached fusing heat, and were then pressed together. It was therefore quite under the control of the operator how cool or how hot he made it before he pressed it. The result was consequently most satisfactory. That was an item with which they ought to credit their American brethren. He was much obliged to Mr. Volk for giving such a comprehensive statement as to the method on which he based his cost of haulage at Brighton. He wished to make a suggestion, and he hoped that the President would cause it to be made as public as possible, because it was one that all who were connected with the transmission of power and haulage had to face. What was wanted was that some basis for calculation of cost should be formulated. Statements were continually made about the cost per mile, but the figures varied so entirely that there must be some difference in the method by which they were arrived at. He thought considerable praise was due to those who had succeeded in getting dynamos used as motors that should maintain a constant speed under a variable load. The most remarkable example of them was the one now at work at the Bessbrook tramway. What was wanted was a motor that would do varying work under varying speeds. The power required to start a tram was very much greater than that required to keep it in motion. None of the cars at Blackpool were worked with worm-gearing, but he had used worm-gearing most successfully upon his Paris car. He had been told that a new process had been discovered and patented by an American whereby sodium was obtained at one-tenth of the usual cost. He would therefore point out that if sodium could be obtained at a very much lower rate the gilt would be taken off the gingerbread of those who were trying to obtain aluminium by some electrical action.

Dr. Hopkinson described his system of overhead conductors to be used for tramways or electric railways. The conductor was hung precisely as a telegraph wire was hung—from insulators overhead, those insulators being kept at approximately the same level. On the car, front and back, a contact piece was arranged transversely, so that the contact could be made with the wire overhead at any point of the width of the car. This arrangement had great conveniences, particularly with regard to going round curves and junctions, owing to the fact that contact could be made at any point laterally upon the car. It had been tested at Bessbrook, and its practicability had been proved. The author of the paper had spoken of the self-regulating property that the shunt-wound Victoria motor possessed—that of a constant potential. That was not a peculiarity of the Victoria dynamo, but was possessed by many others as well. The reason why more regulation was obtained by a shunt-wound motor was that in a generator of electricity, when the current passed in the armature, they had to give the brushes a lead, and the current then in the armature had the effect of diminishing the magnetic field, and that had to be compensated by what was well known as compound winding. In the case of the motor, in order to obtain a constant speed, they would require to diminish the magnetic field, and the brushes had not to have a positive but a negative lead; the current also was in a reverse direction to what it would be in the motor.

Sir James Douglas said the experience he had had had been only in one branch of the subject, namely, electric lighting. He did not agree with Mr. Holroyd Smith that but slow progress had been made in this country in the development of electrical engineering. It had, perhaps, not gone on very rapidly, but upon the whole not slowly. The lead in the new science was first taken in this country, and it had been fairly followed up, but perhaps commercial undertakings had not progressed as could have been wished. Installations which at first were considered to be perfect in a very short time fell back, and had been superseded in the wonderful development that was going on. In his own service when they were commencing it was thought that the machines were perfect, but very soon it was found that the dynamos were nowhere, and they had to be superseded. That was quite sufficient of itself to deter very rapid progress in installations and general lighting in a country like England. He well remembered when Faraday—who he was sure would have been delighted if he had been living now to witness the perfection that had been attained—saw the first dynamo at the premises of the Trinity House, Blackwall, in 1856, he exclaimed, "This was my child, but you have made a man of it." He was quite sure that if Faraday were now alive he would admit that his man had become a giant, and a very great one, too. His (Sir James Douglas's) work had been in the development of electric light for the service of the mariner, but up to the present it had only been employed in cases where oil and gas would not meet the requirements that were demanded. With electricity they had a power that appeared to go actually beyond what was required, and certainly the best installations, and one of the most important, was in a great measure due to Dr. Hopkinson. It satisfied every desire that could be conceived on the part of the mariner, who was perfectly satisfied with it. The only thing that he complained of was that at times he had too much light. He would not attempt to criticise the paper, but would only express his hope that the Institution would afford their meed of praise to the author for the information he had brought before them.

Mr. R. E. Crompton was sorry that the author and Mr. Holroyd Smith said that the practice on this side of the Atlantic was behind that in America. They could hardly admit that. All the great improvements that had taken place in dynamo machines had taken place in England; and certainly the machine which Dr. Hopkinson had designed and perfected was probably ahead of any other machine in the world. The machines made by Messrs. Siemens in London were far ahead of those made in Germany by the same firm. All those machines were far ahead of anything made in America (hear, hear). The largest dynamo in the world had been made by himself. Unlike the dynamo illustrated on the diagram, which had been designed to develop 400 horse-power but only developed 200, his dynamo had been designed to develop 500 horse-power, and had done it. Mr. Holroyd Smith had said he had great hopes of obtaining the cheap production of aluminium on account of the cheap production of sodium. He thought most chemists would support him in saying that a thing so difficult to dissociate from oxygen as sodium was not likely to be dissociated except at a great expense of fuel. The first time he used an electric furnace he could hardly believe that there had been anything more than an ordinary blacksmith's forge going on. Yet he had been having enormous temperatures, and had reduced a large ingot of aluminium bronze containing about 50 per cent. aluminium direct from the corundum. It was perfectly extraordinary that such intense metallurgical action should go on in such a confined space with such little heat to the surrounding bodies. He thought mechanical engineers were hardly aware of the enormous future there was before this new industry of electrical engineering. They hardly appreciated that it had got out of the regions of small telegraphic instruments. The plant his firm were using for turning out modern electrical appliances was more like that used for planing armour plates.

Mr. Cochrane said that, induced by the tempting promises of electricians, his firm had tried an apparatus at their works, which in the matter of development showed some progress beyond that which had been described up to the present time, seeing that it was self-contained, and bolts and gear were entirely disposed of. It was an apparatus capable of running at 10,000 revolutions per minute. It was balanced by a beautiful arrangement of turbines right and left, the steam being delivered into the centre of the apparatus at 50lb. or 53lb. pressure, and coming out at something like 2lb. or 3lb. pressure at the end of the work. That had only been at work a few weeks. He thought in the matter of development, with its splendid bearings and floating in oil—the chief part of the arrangement being to secure a constant supply of oil to the bearings—it was one of the prettiest little arrangements he had ever seen. The makers were Clarke, Chapman and Parsons, of Gateshead.

Mr. Thomas Gower said that his only connection with electrical science had been his practical connection with the Elieson system. On the North Metropolitan tramways they had been running in continuous heavy work for six months. They had covered about 30,000 car miles, and they had carried about 300,000 passengers or more, and in that time they had probably done heavier work than was done on any other electrical system in the United Kingdom. With regard to the cost per mile, he was not at present prepared to talk so glibly as he had heard a good many people. There was a considerable cost with regard to the accumulators; but he thought that electrical engineers would be very wrong if, because of the heavy cost of accumulators at present, they dismissed them as a means of cheap and effective traction. That would be the greatest possible mistake, because engines of the type he was referring to were capable of running on any properly laid line in the United Kingdom from any depot in which they could put a dynamo, a steam engine or a gas engine from that depot, and on those lines they could run those cars; whereas with any system of conductor they had to conquer the prejudices of local authorities and of central authorities. There was the greatest possible difficulty in getting any system adopted, whether overhead conductor or underhead conductor, except in tunnels or such places where they had the practical control of the line. With regard to accumulators, they had their vagaries; but he had come to this conclusion, that it was very largely a mechanical matter to manage accumulators well. In the six months they had been in daily work they had made considerable mechanical improvements in accumulators, entirely irrespective of any electrical knowledge, or of any particular electrical science. He found that very great advantages were to be gained by a different method of packing. The plates were practically screwed together immovably, and the spaces between the places to which these plates were bound were very small. Consequently when any swelling took place in the plates buckling was inevitable. They immediately began to make experiments with a view of letting the plates

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be as free as possible. Since that time the principal accumulator makers in England had gone on in the same direction. The makers had announced to the world that they had been making accumulators on the wrong basis for many years, and they now saw the necessity of making a new type, and that was precisely in the same direction that his firm had discovered was necessary—that was to leave the plates in a free condition, so that there was scarcely any tendency to buckle, and the swelling showed in the direction which would do comparatively little harm. Accumulators should be very readily got at, and very frequently overlooked. He thought that accumulators would be found much more manageable, and that they could be managed with much less cost and with much less depreciation than had been hitherto supposed (hear, hear).

Mr. G. KAPP said that in the first place he wished to defend Mr. Geipel, if such a strong term might be used, against the attack which was made in a letter read at the beginning of the meeting. It would appear from this letter as if Mr. Geipel had not stated the correct facts with regard to the transmission of energy for a distance; but at the time when the paper was written he could not have stated the case as well as it really appeared. He referred to the transmission plant in the neighbourhood of Solothurn, a small town in Switzerland. The author said on page 12 of his paper that there was a turbine of 50 horse-power, and that this power was carried to Kriegstetten, a distance of five miles, and the efficiency was 70 per cent. A letter was read from Mr. Snell, in which he said it was nothing of the kind—that the turbine was 40 horse-power, not 50, and that the power delivered at the mill was 20 horse-power, and therefore the efficiency was only 50 per cent. That was a misconception. When they measured the commercial efficiency of a system of transmission, they did not begin by counting how much *could* the turbine give, but how much did it actually give. Then they compared that figure with the actual power that was received at the other end, not with the power that they might perhaps have, but with the power that they actually got. In this particular case the power put in at the turbine end stands to the power taken out at the other end in the ratio of 100 to 75, and not 100 to 70 as Mr. Geipel stated. But Mr. Geipel was on the right side. He wrote his paper in the summer, before the experiments were made. The first set of experiments were made with this machinery whilst it was still in the shop of the constructors, and there the conditions of actual work could only be got in a more or less imperfect way. They had to substitute artificial resistance for the resistance of the line; they could not foretell what might be the leakage of electricity along the line, which of course would lower the efficiency, and they could not so regularly load their motor. In England we were still ahead of every other nation. Even in Switzerland the designer of this plant is an Englishman. The makers thought it would be advisable to have a correct set of tests made, so they asked six gentlemen of very high standing in the mechanical world in Switzerland to go to this place and actually test it. They would appreciate the correctness of the result when he told them that one of the men on this committee was the inventor of the planimeter. A report was issued by them, and he received an advance proof some weeks ago. By that it appeared that the efficiency was not only 70 per cent., as stated by Mr. Geipel, but actually 75 per cent. Against the other objection that the power was smaller than stated, since the paper was written a 100 horse-power transmission plant had been started at Lucerne by the same designer. He would like to say a word or two upon the very mysterious apparatus which Mr. Holroyd Smith saw in America. That gentleman stated that somebody showed him a box; you put in a continuous high-tension current at one end, and you took out a continuous low-tension current at the other end. He, himself, had seen the same thing, only it was not in a box. It was at the Newcastle Exhibition. He had tested it himself, and he found the efficiency was something like 90 per cent. Since then he had followed up the question a little, and he had found that six or eight years ago M. Gramme, in Paris, did exactly the same thing; but instead of transferring high-tension currents into low-tension currents, he did it the other way about. M. Gramme's object was to telegraph over a long distance where the line has a greater resistance, and where in the ordinary way of telegraphing they would require a large number of cells and batteries to force the current over this long line. He had at hand a small number of fairly large cells, which gave him a large current, but the pressure was insufficient to telegraph to this distance. So he constructed a dynamo, or rather magneto-motor, the armature of which had two circuits, one of thin wire and the other of coarser wire. There were two commutators, and the primary battery was connected with the brushes of the coarse wire commutator. That made the armature revolve, and through the revolution of the armature a current was induced on the fine wire, and that was used for telegraphing on the lining. That was a very self-evident apparatus, there was nothing mysterious about it, and it was being advocated now for use in connection with the lighting of towns where the district is extended. They could have a small wire carrying the electricity from the station to the point of consumption, both for the safety of the people who use the light and for the convenience of having lamps independent of each other. The high-tension current was transformed into a low-tension current, which was distributed now in the same way as if it were generated on the spot (hear, hear). Dr. Hopkinson had told the Institute of his very ingenious system of avoiding the difficulty of switches and crossings in an overhead conductor on an electric tramway. This was really a very great difficulty. With an overhead wire, whether that be a slotted tube in which travelled a contact shuttle, or whether it be a wire upon which ran a small carriage, they could imagine that when they had to make a connection to right or left on the switches it was very difficult to get this little thing exactly to follow the way the carbon had to go. The troubles were so great that the system was practically limited to cases where there was a small line without any branches coming off it. In Scranton, in America, one of the earliest electric lines is working with an overhead conductor, and they had to put in a branch, and they found great trouble with the switches. Then Dr. Hopkinson invented his plan, where there was no need to alter any of the practical arrangements overhead, because the car came and picked up a current, right or left, just where it happened to be. He drew attention to a new system of underground conductors, where the same idea had been carried out. He saw it only last Saturday, and probably it was not yet known generally. It was the invention of Mr. Lineff, and it had been laid down on a small experimental line at the Chiswick depot of the Metropolitan line of tramways. To describe it briefly, it was Mr. Holroyd Smith's underground conductor improved in the way that Dr. Hopkinson improved the overhead conductor. In the Lineff system there was a central slot the same way as in that of Mr. Holroyd Smith. There was a cemented trough that ran all the way along. In the ordinary system of underground conductor there was a conductor put at the side of the slot in order not to be exposed to the dirt or water falling down, and the surface of the conductor must be bare all the way, because the contact rubbed on it all the way. Now the bare surface of the conductor was a disadvantage, because moisture collected on it, and it gave so much facility for surface leakage. In the Lineff system, instead of having a bare conductor there was a conductor which was insulated nearly the whole of its length. It was simply a gaspipe—a ¾in. gaspipe in that case—which was tarred over with some insulating compound. Into the gaspipe is placed, for making it a better conductor, a bare copper wire. The gaspipe was enwrapped with insulating material, and that was laid into cast-iron brackets, which were fixed to the same castings which support the slot. It might be asked, how could the electricity be conveyed to the car if the thing was all insulated? In a very simple way. At every three yards there was a T piece on the pipe, and into the T piece was screwed a kind of saddle. This saddle bends a little outwards, and from the car projects a knife at each end, within which is mounted a copper strip. The knife is bent so to come over the cable, and the copper strip terminates in an eyelet, and upon that was strung an ordinary steel cable. As the car travelled the surface of the cable touched one point after another, but never less than two. Naturally the cable would be used up very quickly when they rubbed it along at a speed of six or seven miles an hour through those cast-iron saddles—naturally the cable would be frayed out, and then the frayed ends might catch. To prevent that, upon the cable were strung a number of gunmetal beads. On these the cable travelled, and when they were worn out they could be replaced without having to take away the whole. The advantage of that was that they could have a crossing—that was one gaspipe conveying a current crossing another gaspipe, so that two cars could be run without interfering with one another. If this were a continuous conductor there would be a great difficulty on account of the conductors meeting (applause).

Mr. HENRY DAVEY took exception to the advocacy of the use of electricity for the purpose of working pumps in mines. Electricity as a distributor of power he fully believed would have a very wide application; but they must be careful not to falsely apply it, because they would only bring it into disrepute, and he was decidedly of opinion that this was a false application. Just let them examine the mechanical details of the arrangements for pumping water from mines by means of electricity. In the first place, he failed to see how it could possibly be applied to draining mines that had large quantities of water, such mines as were usually drained by means of surface or underground pumping engines. He imagined that the application which the author had in his mind was that of draining the dip or remote portions of mines by means of little portable pumps, and even then he thought that the application would be decidedly a false one. The usual method of working dip pumps was to take a little pipe off the rising main of the main pumping engine at the bottom of the shaft, carry it forwards, and apply a little direct acting hydraulic engine to work the pump. Nothing could be simpler than that, and nothing more effective. The efficiency must be much higher than by any electric system that they could possibly devise; and, besides that, these pumps very often became drowned and had to work under water. What would become of their motor? Then, again, in applying the motor to the pump they had a motor which usually ran at 1,100 revolutions per minute, and the pump should not be run at more than 30 or 40 revolutions per minute; and then they had to put in very complicated gearing to get down the speed, and in doing so the loss of efficiency must be very great indeed. He was perfectly convinced in his mind that any such application of electricity must in the end prove a practical failure. It struck him that where electricity would come in more extensively in use would be where power was to be transmitted for a very considerable distance, and there it did appear to possess in point of efficiency very decided advantages indeed, even judging from the limited experiments which had been already carried out. Then it afforded a ready means of utilising water power in districts which possessed that water power and which were remote from centres of industry. In that direction the transmission of power by electricity would come in better than any such limited application as that of applying it to the working of underground machinery in mines, which was at present done by very satisfactory and very practical machinery.

Mr. MORDEY said it had been remarked that the Victoria machine was not singular in being able to give a very constant speed with varying loads when supplied with constant pressure currents. But at the same time that he published that curve in the *Philosophical Magazine* his object was to draw attention to the fact—which was not then known, or at any rate was not then recognised, that simple shunt machines were capable of being made perfectly self-regulating. Only a few weeks before that the German Hopkinson (Dr. Fröhlich) had published a full investigation on the question of the regulation of motors, and although he had spoken of shunt motors, compound motors, and differential motors, he had entirely missed the point which was necessary to obtain constant speed regulation in shunt motors. He (Mr. Mordey) therefore published that curve simply to show that shunt motors would give constant speeds, and to point out that the right way to construct the motor was pretty much in the same way as the dynamo, to make a strong field and a weak armature magnetically. Up

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to that time it had been generally recognised that motors should have a very strong armature magnetically, and a very small weak field was the right principle to use. He thought Mr. Holroyd Smith and Mr. Crompton were both right, although they differed from one another entirely as to the opinion about the practice in America. The practice was ahead in America in the sense that as soon as the Americans got hold of anything that would work they applied it. All the improvements in dynamos and in motors practically had been rejected on this side of the Atlantic; but in America they had applied electricity for lighting purposes and for power transmission to an almost infinitely greater extent than we had done on this side of the Atlantic, and particularly in this country. We seemed to make the improvements for the Americans to make money out of, for they took them and applied them. Since the application of the curve there had been made and used by one company in America over 5,000 motors. He did not think that all our motors put together since that time would amount to fifty, and he thought that mechanical engineers were a little to blame for that. He did not think they quite recognised the capability of electrical transmission, and they did not know what a tool electricity gave them. He hoped that paper would open the eyes of those doubtful upon this subject, as to the great advantages of electricity for purposes quite apart from lighting. As to the big Brush machine, he did not know that the machine only gave off half of what it was supposed to give. It was some time since he looked up the official test; but, as far as he knew, that machine gave rather more than was arranged for. The Cowles Company had ordered two or three machines of the same type, and the same size, and one larger, so that he did not think there could be any question as to the machine only being capable of doing half the work that it was supposed to do. There was no doubt that the electric light plant was now, and had been for some years, going out of the experimental stages, and from the fact mentioned by Mr. Geipel that a dynamo was running day and night for a couple of years, and only stopped on Sundays—because it was in Scotland, he supposed—there was no doubt that the plant was trustworthy.

Mr. ARTHUR SHIPPEY said there was no getting over the fact that electricity had just begun to make a very big headway, and that the one thing they wanted was cheap power; and he thought there was the means of giving them a cheap power, and that was by the utilisation of the waste gases of their coal mines, as there was no getting over the fact that waste gas could be used, and used very profitably too. On this question of the utilisation of fire-damp, he should quote from a paper in which it was stated that "it was very interesting to see fire-damp, the most dreaded enemy of miners, reduced by the genius of man to be his agent and servant, as has been done in Germany recently. The Wurm coal mines, near Aix-la-Chapelle, are particularly noted for the amount of fire-damp produced in them, and the minutest precautions had to be taken to prevent dangers that, notwithstanding this, were to be feared. Mr. Hilt, director of the mines, undertook the work. He constructed a line of piping that ran in front of all the centres of work, and ended in a main pipe connected at the surface with a powerful suction pump. But it was not enough to get rid of the noxious gas, it was necessary to utilise it, and so Mr. Hilt conceived the ingenious idea of causing the conduit to end in a gasometer. Upon isolating the latter, and placing wire gauzes here and there in the conduit, he was enabled to lead the gas to the furnace of two generators, and use it to help to heat them. "We are obtaining," says the director, "30,500 cubic feet of fire-damp, which distils 263 cubic feet of water. On uniting the fire-damp of all our exploitations we shall have 64 cubic feet per minute, and shall be able to distil 5,260 cubic feet of water per twenty-four hours. The utilisation of fire-damp thus stored may become advantageous from a commercial point of view. It may serve not only for gas motors but also well-constructed dynamos for lighting purposes." He had taken some pains to get some statistics on the question of fire-damp and waste gases in the Rhondda Valley, and taking the calculation of the quantity of power that ventilated the mines, and to get out the gas which existed there. To a very large extent it showed that there was nearly half a million of valuable fuel going to waste. If that was converted into steam for the purpose of use in some of the large machines of 500 horse-power, and the application of transformers, there was no difficulty in conveying that electricity, and generating it at the pit's mouth in a radius of 50 miles in England. There was no getting out of the fact that the colliery proprietors had every chance before them of lighting their mines by electricity, and lifting the coal, and in this way there was a great future for electrical engineers combined with mechanical engineers. There was a very great field for some of the engineers to construct a cheap and useful engine.

Mr. GEIPEL, in reply, said the paper spread over a large area and a wide field, and it was difficult to confine himself to any fixed point. Referring to the remarks of Mr. Fearfield, which had been answered to a great extent by other speakers, he complained that good engine drivers were not able to look after dynamos on account of the armatures scrubbing, the commutators wearing, and the brushes sparking. He thought Mr. Fearfield must have been particularly unfortunate in his experience, for he (Mr. Geipel) had had a good many installations under his control from time to time, and in very few cases were they able to get engineers to look after dynamos. They had got to be satisfied with men who oil shafting, with sugar boilers, as in the case of Messrs. Jager's dynamo, or other unskilled attendants. If anything happened or went wrong with Messrs. Jager's dynamo—it had not happened for two years—it would, of course, be necessary to call in experts, but as for oiling the bearings, adjusting the brushes, and keeping the dynamos clean, he did not think it should be requisite for engineers at all. That might also refer to motors equally well. There was no reason why a man should not oil his own motor and his own machine, and keep it running satisfactorily. Mr. Fearfield had also mentioned that the size of the installation had very much more to do with the cost of working than the time the installation was used per annum—that was to say, the amount of use they could get out of that installation. It did not do to take that too far, and to say that they could put down one lamp and an installation for that one lamp and work it as cheaply as a hundred. But, taking a reasonable average installation of 500 or 1,000 lamps, the cost of working that was very much more dependent upon the time that the installation was in use than upon the comparison in the size. He got out a curve, shown in the diagram, showing the cost of the light per hour, as compared with the number of hours of use per annum. Above a thousand hours it seemed to be fairly constant, but in going back to a hundred hours it rose very rapidly. Mr. Walker thought that five to ten per cent. was too much to lose in the mains. That depended very much upon the cost of the power that he was prepared to lose, and the cost of the conductors. It depended greatly upon the time in which the current was used and also upon the cost of copper and the cost of insulating that copper; in fact, in one of the diagrams it was shown how much potential it was economical to lose for the different cases. It did not follow that in all cases 5 to 10 per cent. might be lost; but that was not an unreasonable amount to lose, more especially in this country where coal was so cheap. Mr. Walker had also asked how a six horse-power motor did the work of a ten-horse engine. Well, the term ten-horse engine was merely nominal, in the first place; secondly, the torque of an engine (that was the twisting moment) did not increase with the load even if the load tended to pull up the engine. On the other hand, if they attempted to slow down a motor by putting on a brake they increased the torque. He did not mean to say they increased the horse-power developed, but they increased the amount of machinery that a motor in use was able to drive. By throwing on an extra printing machine it was possible for the engine to be drawn up or stopped from the mere fact that the engine was only capable of exerting a certain torque, whereas with a motor, if they tried to draw it up, it increased the torque and its power of overcoming the increased work for the time being. Mr. Schoolbred had asked if 200 volt lamps were obtainable. He was sorry to say that he had not been fortunate in coming across them, although Mr. Swan, who had had some experience in lamp manufacturing, saw no difficulty, or no reason, why they should not be made by improved manufacture. At the same time the curve was not drawn wholly to represent the resistance of the lamps themselves, it also embraced the potential used in the supply mains; 200 volts was quite a possible potential to use with existing lamps of 100 volts on the three-wire system. The question as to the joining the electric rails in America had been answered by Mr. Volk. There should be no difficulty in joining the rails in various methods. Even with fish-plates alone, without any other connection, he had known ordinary rails, connected by fish-plates, work quite satisfactorily provided that the rails did not carry the going and return currents, but were merely used as returns. Mr. Holroyd Smith would have preferred more details of the different applications mentioned in the paper along with the why and the how; but he (the author) thought this paper already sufficiently long, and would point out that his object had been to put before the mechanical engineers the actual practical position of electricity as an agent, as well as some of the chief uses to which it could and had been put, and not to enter into calculations of elaborate formulæ and mathematical theories, which he preferred to leave to others more capable of dealing with such than he was. Mr. Smith had misunderstood his remarks about the Americans. He did not wish to depreciate one iota the immense amount of good work done by our friends; what he meant to convey was that American engineers had taken advantage of what European scientists had discovered. He did not consider that Houston, or Brush, or those gentlemen he (Mr. Smith) had named, with the exception of Franklin, were scientists; they were practical engineers, or practical electricians, and had taken advantage of the discoveries of Faraday, Gramme, and other Europeans. He agreed with Mr. Smith that the samples of welding sent by Dr. Benardos were bad; but he thought Mr. Smith was premature in condemning this system altogether until further trials had been made. He (Mr. Geipel) thought that better results might be obtained by increasing the size of the arc, or by using more arcs than one so as to render the heating less local. He was not sufficiently practical to suggest that some flux might possibly facilitate the welding. Mr. Smith did not mention what items he had found omitted in the cost of working the tramway. He did not think his suggestion as to a basis for calculation of cost likely to be taken up seriously, the conditions of operating rail and tramways were too numerous and diverse; it was not a difficult calculation to arrive at the working cost of any railway in operation. He had not mentioned, as Dr. Hopkinson seemed to imagine, that self-regulation was peculiar to a Victoria motor; on the contrary, his statement was that *an ordinary* shunt-wound motor was self-regulating. He bore out Mr. Mordey's remarks as to the "Brush Colossus Machine," and thought it unlikely, if Mr. Crompton's remarks were true, that Messrs. Cowles would have since entrusted additional orders for similar dynamos to Brush, as he understood was the case. Mr. Crompton had called attention to what he thought was a weakness of the shaft of this dynamo, but he had omitted to inquire into the question of speed. He thought such details tolerably safe in the hands of Brush. Regarding Parsons' generator, he understood that it consumed upwards of 60lb. of steam per horse-power-hour, and although the compactness of the apparatus rendered it suitable in some cases, yet engines could be obtained to work with less than half that amount of steam. Mr. Davey was wrong in suggesting that he (the author) had in his mind little portable pumps; indeed, he had already tendered under guarantee for several large plants. One was for pumping 500 gallons per minute to a height of 200 fathoms, and he saw no difficulty in doing the work. He did not agree that the direct acting hydraulic pump *must* be more efficient. Did Mr. Davey calculate the loss by friction in the pipes and in bends as well as the loss due to the compression of air, which always found its way into hydraulic pipes in smaller or larger quan-

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tities? It was difficult to get at the efficiency of hydraulic pumping; at any rate, it was easier to test the efficiency of electricity. Speaking of efficiency, he could mention a case of a colliery in Scotland where they had put in hydraulic plant; it was found that the stroke at the pump was about two-thirds of that at the receiver, although the ram at the engine was larger than that at the pump. He had pointed out to the proprietor of the colliery that this meant a loss of power; his reply was that the difference in stroke could easily be remedied by increasing the diameter of the ram at the engine. He hoped Mr. Davey appreciated, what this gentleman did not, viz., that the work exerted or delivered was an exact multiple of the area of the rams. There was no reason why motors should run at 1,100 revolutions; they could be supplied to run at 200 revolutions or less even, and an efficiency from engines to pump of 75 per cent. could be guaranteed. The author had hoped that some gentleman advocating compressed air would have joined in the discussion; as this was not the case he took it that the mechanical engineers admitted the claims he made in favour of electricity as to efficiency. With regard to the question asked by the President as to the working expenses of Messrs. Jager's installation, these figures were given to him by the Messrs. Jager themselves. The power required was merely calculated. The actual consumption of coal was also merely calculated. The dynamo was driven by a large engine, and it was driving other machinery. 3lb. per horse-power was a liberal calculation, but it was merely a calculation. He did not mean to say that in every case a saving could be made; in such a case as Messrs. Jager's the engine was running whether the dynamos were there or not; it cost nothing extra for firemen's wages, and the extra wear and tear of engine and boiler was neglected. The total number of lamp hours calculated from the gas consumption, and verified by subsequent calculations, was roughly 300,000, say 40,000 indicated horse-power-hours; in Leith ¼d. per horse-power-hour is a liberal allowance for all charges, including labour, fuel, oil, and depreciation on engine, boilers, &c. (all night work). 40,000 × ¼d. = £42, and substituting this for the £12, calculated by Messrs. Jager for coal, would reduce the yearly saving to £174. 0s. 4d., which included a liberal charge for horse-power.

The PRESIDENT, in proposing a vote of thanks to the author, said it was a fortunate thing that they had had a sort of *résumé* which had enabled them to take the subject in all its branches. They need not be ashamed of their electrical engineers—for they were going to find a large amount of work for the mechanical engineers in the future—but he should like any gentlemen to supply their secretary with any reliable data or facts as to the cost of lighting. He differed rather from Mr. Geipel, because his paper was very theoretical. There was nothing included for the driving of the engine, and the fireman and the firing of the boilers, and no labour whatever. The question ought to become, whether electric lighting of the future was driving the gas companies on to use the gas works for some other purpose. When he said it was far cheaper to make their coal into steam, and thereby create an electric current and have an electric light, the gas companies had this advantage—they had residuals, which any person burning his own coal did not get. The gas companies could afford to give them their gas for almost nothing if they could get a fair price for their residuals; and notwithstanding the improvements in electric light gas companies had gone on paying higher dividends ever since the electric light had come in. Electric light had forced everybody to go in for more light, and although nearly everybody was burning more gas the price of gas was reduced. But the important question was the cost of the electric light. What could you do compared with the cost of gas supposing you had 50, or 100, or 150 lights?

The proceedings then terminated.

THE LIGHTING OF THE CITY.

At the meeting of the City Commission of Sewers, held on Tuesday last, at which Mr. W. H. Pannell presided, the Streets Committee brought up a report submitting for adoption an amended arrangement with the Anglo-American Brush Electric Light Corporation for lighting a district of the City by means of electricity. The district to be lighted commenced from the front of the Royal Exchange, and comprised so much of the City as lies between the Poultry, Cheapside, St. Paul's, Ludgate-hill, and Fleet-street on the north, and Queen Victoria-street and the Embankment on the south.

Mr. J. C. BELL, in moving the adoption of the report, referred to the previous connection of the Commission with experiments in electric lighting in the City. In 1878 they tried the Jablochkoff system, at an expense of seven and a-half times the cost of gas, but, as far as they could judge, it failed. In 1881-82 they entered into contracts with three companies for experimentally lighting the City at the same time, to test which was the better system. The Brush Company charged for works, installations, and lighting in the district allotted them £1,410, or twice the cost of the gas there, but the light gave 15 times more illuminating power. The Lontin system cost £2,930, or four times the cost of gas, the illuminating power being 14½ times greater; and the Siemens system cost £3,720, or 3¾ times the cost of the gas in the district allotted them, the illuminating power being 13½ times greater. They afterwards entered into a contract with the Edison Company for lighting a part of the City with incandescent lights. None of these systems of experiments gave satisfaction. The terms of the present proposed contract with the Anglo-American Brush Company were double the price of gas in the same area—viz., £4,394, instead of £2,200—but they would get 32 times the amount of light. It was contemplated to use 196 arc lamps of 2,000 candle-power each, at a cost of £26 per annum each. The committee had selected the most frequented parts of the City for the experiment, but if it proved a success, there would be no difficulty in extending it throughout the City. He believed the contract was not only a fair one, but virtually a one-sided one in favour of the public. They had had complaints from many quarters of the insufficiency of the lighting in the City, but any increase in the number of gas lamps would be very expensive. Electric lighting would not only afford a greatly better light, but would minimise the risk of fire and tend to the protection of property. The cost would necessitate an increase of one-eighth of a penny in the pound on the ratable value of the City, of which about one-fifth of the whole area would be lighted by electricity. To those who had any experience of the atmosphere of the large establishments of the City, where hundreds of workpeople were employed—such as the printing offices—the advantages to health by the introduction of the electric light would be patent. While it was proposed to make a contract for a term of seven years, any failure of the company to observe its provisons would not only bring about its immediate cancelment and the forfeiture of the deposit of £1,000, but would inflict on the company the loss of their monopoly of private lighting, so that in their own interest the company would take care to have no failure. The whole of the installation was to be finished by October, 1889, but they hoped to have the City lighted street by street as the work progressed. The company would have, as far as the Commission could grant it, a monopoly of private electric lighting in the district, but they could not compel the inhabitants to use it, and it was, therefore, to their interests to make the charges as low as possible in order to secure orders and to compete with the gas supply. The same monopoly of lighting was now given to one gas company, with the result that the cost of public street lighting was decreased. In the present case it was estimated that each arc lamp in the streets would cost £40 per annum to the company, who would therefore lose £14 on each lamp; but they would bear this loss for the sake of the monopoly of private lighting. If the experiment proved successful they might go to other companies and get better terms, and if it were a failure they could fall back upon the gas, besides making the company pay for the failure. It had been suggested that the commission might undertake the work more economically and just as efficiently themselves, or, at all events, that they should have a right of pre-emption of the shares of the company, but as electric lighting was still in its infancy, he thought that at this period they had bettler let other people, who understood the work, do it. He contended that arc lighting was the proper mode for illuminating a city such as London, and observed that the contract contemplated the provision of shadowless lamps, and of glow lamps in the smaller streets. He believed that if the work was carried out as proposed the Commission would be entitled to the thanks of the community. At all events, they would be likely to bring the gas companies to their bearings. Even that small agitation had had the effect of reducing the price of gas by 6d. per 1,000, and he hoped that sooner or later the gigantic gas monopoly would be broken down. For these reasons he urged the Commission to adopt the report.

Mr. C. T. HARRIS, as an amendment, moved that the report should be referred back for further consideration. He argued that the present lighting of the City, as far as all practical purposes were concerned, was perfectly sufficient, and that anything further would be merely a luxury, for which the ratepayers should not be called upon to pay an increased tax. He objected to the report on four grounds—viz., because arc lighting was unsuitable for the purpose; because the illuminating power could not be adequately estimated, and was therefore enormously exaggerated; because the cost was prohibitory, and because he considered the terms of the contract open to grave criticism in the interests of the public. On these grounds he begged the Court to give the matter further consideration.

Mr. J. E. SLY observed that four or five years ago a great deal of money was spent by the Commission in experiments with the electric light. It was hardly for the Commission to contemplate lighting one portion of the City at the expense of the other. They had shown their desire for the light by the large sum of money they had spent in experiments. If they contemplated adopting the electric light it ought to be for the whole City. The Maxim-Weston Electric Light Company would supply the electric light to the whole City at £15,000 for the first cost, fitting, &c., and £3,875 a year for maintaining the light—800 lamps of 450 candle-power each being supplied. This would pay itself in two years. He asked them to reconsider the matter, so as to get it done in the cheapest way they could, and not to have a seven years' monopoly.

Mr. BRIDGMAN referred to the insufficient manner in which the City was lighted as compared with the Holborn District, and observed that he did not know a more dismal place than the neighbourhood of St. Paul's at night. The electric light had been adopted in New York, Brooklyn, Paris, Vienna, and some towns in England.

Mr. MORTON said he was strongly in favour of getting the electric light, but they did not want to be entrapped.

Mr. J. V. MOORE supported the amendment. He referred to the improvements which had taken place in gas lighting, and observed that gas was becoming a formidable rival to the electric light. A new lamp had been brought over from Berlin which gave a wonderful light at a consumption of only 12ft. of gas per hour. The Court could not, consistently with its duty, agree to the report, and it ought to be sent back for further consideration.

Mr. L. H. PHILLIPS and Mr. G. SHAW also supported the amendment, while Mr. Deputy SCOTT warmly advocated the adoption of the report.

After some further discussion the amendment was declared to be carried on a show of hands. A division was demanded, with the result that the amendment was carried by 36 to 17. The report was accordingly referred back for reconsideration.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

2,073. A. C. IWANOWSKI. London. An improved electric alarm apparatus. February 11, 1888.

2,088. J. G. GILCHRIST. Glasgow. Improvements in dynamo meters. February 11, 1888.

2,125. W. ROWBOTHAM. Manchester. An improved method of constructing and regulating arc lamps. February 11, 1888.

2,130. A. MUIRHEAD. London. Improvements relating to electric telegraphs. February 11, 1888.

2,170. F. W. WHITE. London. Improvements in bases and covers of switches or cut-outs used in electric lighting. February 13, 1888.

2,178. R. N. BOYD. London. Improvements in plates for secondary batteries. February 13, 1888.

2,179. M. WHEELER. London. Electric lights. February 13, 1888.

2,235. J. A. BRYCE. London. Improvements in or applicable to electric conductors. February 14, 1888.

2,239. J. T. MAYFIELD and J. T. TODMAN. London. An improved electrical door and window contact. February 14, 1888.

2,246. H. H. LAKE. London. Improvements relating to dynamo electric machines (R. Eickenmeyer, United States). February 14, 1888.

2,250. J. H. LINVILLE. London. Improvements in printing telegraphs. February 14, 1888.

2,251. A. GRAHAM. London. Improvements in switches for electric circuits. February 14, 1888.

2,259. H. MESTERN. London. Improvements in thermo-electric and furnace batteries. February 14, 1888.

2,304. S. SUDWORTH and E. L. BERRY. London. Improvements in fireproof "batten" lights for electrically lighting the stages of theatres and other similar buildings. February 15, 1888.

2,308. C. COERPER. London. Improvements relating to dynamo electric machines. February 15, 1888.

2,313. S. ZIANI DE FERRANTI. London. Improvements in dynamo electrical machines and apparatus used in connection therewith. February 15, 1888.

2,314. S. ZIANI DE FERRANTI. London. Improvements in electrical safety fuses. February 15, 1888.

2,315. S. ZIANI DE FERRANTI. London. Improvements in electrical mains. February 15, 1888.

2,316. S. ZIANI DE FERRANTI. London. Improvements in dynamo electrical machines and apparatus used in connection therewith. February 15, 1888.

2,368. M. BAILEY and J. WARNER. London. An improved method of manufacturing woven plates for secondary batteries. February 16, 1888.

2,369. J. ORME. London. An improved system of electrical or other signalling between signal cabin and driver and guard in charge of railway trains in motion or otherwise, and apparatus therefor. February 16, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

February 18, 1888.

2,598. T. P. HEWITT. Liverpool. Improvements in electric gaslighters. February 19, 1887.

5,096. G. KAPP. London. Improvements in dynamo-electric machinery. April 5, 1887.

5,485. J. HARGREAVES. Liverpool. Improvements in and connected with internal combustion thermo dynamic engines. April 15, 1887.

5,583. H. LIEPMANN (of the Liepmann Carbon Company, Limited). London. Improvements in galvanic batteries. April 16, 1887.

8,396. A. J. MARQUAND. London. Improvements in electrical apparatus for preventing corrosion or incrustation of steam boilers and other similar vessels, and for removing the incrustation when once formed. June 10, 1887.

100. H. H. LAKE. London. Improvements in and relating to apparatus for generating electricity (W. Humans, United States). January 3, 1888.

623. R. J. GULCHER, and the firm of J. PINTSCH. London. Improvements in thermo-electric elements and piles. January 14, 1888.

PATENTS SEALED.

February 10, 1888.

15,719. J. ROOTS. Orpington. Improvements in apparatus for administering electric currents. December 1, 1886.

16,608. D. G. FITZ-GERALD. London. An improved method for the production of coherent masses of peroxide of lead for use as voltaic battery elements and for use in electrolytical and metallurgical operations. December 17, 1886.

1,390. R. C. JACKSON. London. Improvements in dynamo-electric machines and electro-magnets. January 28, 1887.

1,609. W. J. BARNSDALE. London. Improvements in and connected with electrically wound clocks. February 1, 1887.

1,667. M. McMULLIN. London. Improvements in the application of electricity to illuminative and other purposes in theatrical and analogous representations. February 2, 1887.

14,893. L. G. WOOLLEY. United States. Improvements in generation of electricity. November 1, 1887.

14,901. C. R. GOODWIN. Paris. Improvements in electric batteries. November 2, 1887.

February 14, 1888.

15,774. J. PROBERT. Surrey. Improvements in electrical switches and appliances connected therewith. December 2, 1886.

1,741. S. SUDWORTH and C. K. FALKENSTEIN. London. Improvements in apparatus for making and breaking electrical circuits. February 3, 1887.

1,862. C. D. ABEL. London. Secondary batteries (A. Dunn and C. Hasslacher, Germany).

1,929. C. D. ABEL. London. Improvements in galvanic batteries (A. Dunn and F. Hasslacher, Germany).

SPECIFICATIONS PUBLISHED DURING THE WEEK.

747, 1887.—F. WYNNE. Applying electricity to propel vehicles. (Price 8d.)

949, 1887.—G. PERCIVAL. Electrical switch. (Price 8d.)

2,419, 1887.—F. BOSSHARDT. (Hillaire-Desbois.) Dynamo electric machines. (Price 8d.)

4,546, 1887.—C. D. ABEL. (Siemens and Halske.) Dynamo electrical machines in combination with motor engines. (Price 8d.)

4,553, 1887.—W. DICKENSON. Electric telegraph apparatus. (Price 11d.)

4,914, 1887.—R. D. SMILLIE. Switches for electric circuits. (Price 8d.)

7,530, 1887.—J. G. STATTER. Electrical transformers. (Price 8d.)

15,858, 1887.—W. MAIN. Dynamo electric machines, &c. (Price 1s. 1d.)

16,032, 1887.—W. MAIN. Electro-motors, &c. (Price 11d.)

LEGAL INTELLIGENCE.

The Faure Electric Accumulator Company (Limited) v. Philippart.

This case came on last Saturday in the Queen's Bench Division before Mr. Justice Hawkins.

The liquidator of the plaintiff company, which was being wound up, claimed to recover from Mr. Simon Philippart, a former director of the company, £70,459 for calls in respect of shares. The amount was made up as follows:—A first call of £1 made in November, 1882, on 22,532 ordinary shares of £10 each, standing in the name of the defendant, and forfeited in January, 1883; a second call of the same amount made on the same shares in December, 1882; two calls of £1 each on 2,000 ordinary shares standing in the joint names of defendant and Mr. E. L. Broubenge, together with interest at the rate of 10 per cent. in accordance with Articles of Association. The defendant denied his liability on a variety of grounds, asserting that the shares were held by him as trustee of a Belgian company entitled the Société La Force et la Lumière; and the plaintiff company, being well aware of the circumstances, had agreed that the shares should be forfeited, on the terms that neither defendant nor the Belgian company should be liable for either calls or interest. The Belgian company assisted, it was said, in promoting the Faure Company, and paid £50,000 in cash on the shares, and the arrangement was, it was contended, because of the large cash payment, that forfeiture should be a discharge of all liability. In regard to the second call the defence was that it was invalid, as it was made at a Board meeting, attended by only two directors instead of a quorum of three, as required by the Articles of Association. Furthermore, defendant contended that he had ceased to be liable because he had been bankrupt in France, and the liquidator had recognised the bankruptcy. On behalf of the plaintiffs, however, it was contended that defendant had not been discharged from liability, and it was denied that the bankruptcy had been recognised. As to the second call, it was said the quorum should, according to the Articles of Association, consist of three until otherwise determined, and in April, 1882, the Board resolved that two directors should form a quorum.

Mr. Channell, Q.C., and Mr. Grosvenor Woods appeared for the plaintiffs, and Mr. Finlay, Q.C., Mr. Henderson, and Mr. Merrick represented the defendant.

At the conclusion of the arguments his LORDSHIP said the matter was of some nicety, and he would take time to consider his judgment.

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COMPANIES' MEETINGS & REPORTS.

The Brighton Electric Light Company.

We have been furnished with the following report:—

A meeting of the Brighton Electric Light Company's shareholders was held at the works of the Company on Saturday evening, and great satisfaction was expressed at the nature of the report for the past fifteen months.

The managing director, Mr. Arthur Wright, was congratulated on the successful manner in which he had conducted the Company's business. There had been a great increase in the consumption of electricity, and the plant had recently been considerably added to in order to still further cope with the business coming before the Company.

It was resolved that an expenditure of £3,000 be made on additional plant, and the shareholders expressed their willingness to take up a certain amount of new shares, but it was felt that an opportunity should be afforded to the residents of Brighton and Hove, and especially to the Company's customers, to take up a portion of the capital to be issued, and that after showing the result of a fair amount to be set aside for a reserve fund and a 5 per cent. dividend, many local investors would like to become shareholders.

On the motion of the CHAIRMAN, seconded by Mr. SMITHETT, the report and accounts were unanimously adopted.

A hearty vote of thanks was given to the Chairman and Directors of the Company, and in reply the CHAIRMAN mentioned that with the new plant at their disposal, the Company would be able to adopt the plan of continuous night and day service.

Mr. WRIGHT, in returning thanks, said that the plant and apparatus on the Company's premises were in the highest state of efficiency, and that from the gradual increase of business month by month he expected to be able to show even more satisfactory results next year.

Telegraph Construction and Maintenance Company.

Report of the Directors, to be submitted to the members at the twenty-fourth ordinary meeting to be held on Tuesday, the 28th inst., at one o'clock precisely:—

2. The accounts for the year show a net profit of £88,798. 6s. 7d. after charging the interest on the debentures. To this sum must be added £51,278. 4s. 3d. brought forward from last year, making a total of £140,076. 10s. 10d. From this amount is deducted the interim dividend of 5 per cent., paid July 19th, 1887, amounting to £22,410, leaving £117,666. 10s. 10d. to be dealt with. Of this sum the Directors propose to distribute a dividend of £1. 16s per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid a total dividend for the year of £2. 8s. per share, or 20 per cent., free of income-tax, leaving £50,436. 10s. 10d. to be carried forward to the next account.

3 During the past year a considerable amount of work has been carried out by the Company in the manufacture, laying, and repair of cables in various parts of the world. The gutta percha department has manufactured a length of over 8,000 miles of insulated telegraph wire, and the cable factories have been actively employed during the greater part of the year. The Company's steamships have made voyages to the Red Sea, (Perim, Assab, Massowah, &c.), to the Mediterranean (Gibraltar, Malta, Zante, &c.), and to the Atlantic (Lisbon, Halifax, Valentia, &c.). Cable repairs have also been executed in the North Sea and English Channel.

4. The Company's ss. "Kangaroo" has been chartered to the Italian Government for distilling purposes in the Red Sea.

5. The Company's steamship and the factories at East Greenwich and Wharf-road are in efficient working order.

6. The retiring Directors are Sir George Elliot, Bart., and Mr. Philip Rawson, who, being eligible, offer themselves for re-election.

7. The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (Messrs. Gane and Jackson), and Mr. James Glegg (Messrs. Quilter, Welton and Co.), who retire, offer themselves for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 17th February were £4,420.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended February 17th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,612.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended 15th February amounted to £3,310, as compared with £3,012 for the same period last year.

M. Eugène Martin has joined the Board of the Compagnie Continentale Edison.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Feb. 22, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Feb. 22, 1888. Highest.	Lowest.
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American ....xd	39½ 40	3 9 7	Jan., Apr., July, Oct.	40¼	...
2,614,820	Stock	20/0	Do. Preferred ....xd	65½ 66½	4 2 5	,, ,,	66¾	66½
2,614,820	Stock	nil.	Do. Deferred	14 15	...	February	14 11/16	14½
130,000	£10	3/0	Brazilian Submarine	11¾ 12	5 19 2	Mar., June, Oct., Dec.	12	11 13/16
16,000	10	8/0	Cuba Submarine ....xd	12¼ 12¾	6 3 2	February and August	12⅜	...
6,000	10	10/0	Do. Preference ....xd	18 19	5 5 3	,, ,,	18	...
			Direct Spanish	3¼ 3¾	...		...	...
6,000	5	5/0	Do. Preference	8½ 9½	...	April and October ...	...	...
60,710	20	2/0	Direct United States	8⅞ 9⅜	4 5 4	Jan., Apr., July, Oct.	9	...
380,000	10	2/6	Eastern	11⅝ 11⅞	4 15 8	,, ,,	11 7/16	11¼
70,000	10	3/0	Do. 6 per Cent. Preference	14¼ 14¾	4 1 4	,, ,,	14½	14⅜
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 13 6	February & August	...	...
250,000	10	2/6	Eastern Extension	12¼ 12½	4 15 8	Jan., Apr., July, Oct	12½	12 1/16
22,050	10	5/9	German Union Telegraph and Trust	8¾ 9¼	6 13 4	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅝ 5⅞	4 18 0	Jan., Apr., July, Oct.	5⅞	5 11/16
178,992	10	3/0	Do. 6 per Cent. Preference	13⅜ 13⅞	4 8 0	,, ,,	13⅝	13 7/16
150,000	10	5%	Great Northern	13¾ 14¼	5 5 6	Jan., July, and April	14⅛	13¾
17,000	25	5/0	Indo-European	38 40	6 5 0	April and October ...	...	...
			London Platino Brazilian	4¾ 5¼	...		5⅛	4⅞
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October ...	...	...
338,225	Stock	12%	Submarine ....xd	135 145	10 4 4	February & August	...	...
30,000	10	6/0	West Coast of America	5¼ 5¾	4 11 3	January and July ...	5½	...
			Do. Debentures	111 116	...		...	...
88,321	10	nil.	West India and Panama	¾ 1	...	—	...	...
34,563	10	9/0	Do. 1st Preference	9½ 10	7 10 0	April and October ...	10	...
45,181	15	3/9	Western Brazilian	9 9¼	7 15 6	March & September	9 3/16	9
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 104	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	9/16 11/16	5 9 0	Yearly	...	...
			Oriental	¼ ½	...		...	...
80,000	£5	5/0	United	13¼ 13¾	5 6 6	June and December	13½	13⅛
			United River Plate	4¾ 5¼			4 15/16	...
			ELECTRIC LIGHT.					
	5		Anglo-American Brush (£4 paid)	3 3½	...		3½	3¼
23,692	5	nil.	Do. (fully paid)	4 4½	...	February & August	4⅝	4
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2½	...		2⅜	2
312,000	¼	0/1¼d. '86	Maxim-Weston	3/16 5/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	39 40	6 3 0	March and July	40	39¼
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16 17	6 5 0	February & August	17¾	15¾

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THE ELECTRICIAN:

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NOTES.

The question of battery *versus* alternate-current transformers, which is now being so hotly contested, is dealt with this week in our leading article; but we may here note one or two points which space does not permit us to refer to at length. As to the alleged difficulty of running alternating machines in parallel, of course, it is understood that the difficulty only occurs when one machine has to be switched on to another already at work. If the alternations do not coincide, the leads will then be practically short-circuited while the two machines are getting into step. Messrs. Siemens, however, propose to get over this difficulty by a device which is, at least, good in theory. An electro-magnet is provided with two independent high-resistance coils; when the machines are running at the same speed they are each connected with one of these coils. The armature of the electro-magnet is held back by a spring which is so adjusted that it is only pulled down when the core is magnetised by the two coils simultaneously. The armature cannot fall, therefore, until the machines are working in unison, but immediately this has been attained the armature falls and closes the circuit of the second machine upon the mains.

Mr. Kapp said on Thursday evening that he should be unable to believe in the existence of magnetic lag until someone explained how its existence could be reconciled with the fact that a telephone can reproduce a high-pitched voice better than a low one. If Mr. Kapp will refer to *The Electrician* of August 12th, 1887, page 286, he will find an interesting account of the researches of MM. Grassman and Lahr upon this very point. The explanation arrived at by these authors is very simple, though not a little curious. It is that the male voice, though of lower pitch in the fundamental tones, yet contains harmonics far higher in the scale than those belonging to the female voice. In the soprano voice the whole of the tones belonging to a given note and its harmonics are comprised within a comparatively narrow range upon the diatonic scale. In transmission by telephone, therefore, these tones are all degraded to about the same extent, and the characteristic *timbre* of the voice does not much suffer. In the male voice, on the other hand, not only is the fundamental tone deeper, but the harmonics are higher, and the range covered by a single tone is far greater. Hence, some waves are much more retarded than others, and the final distortion is, or may be, so great that a man's voice is unintelligible where a girl's is perfectly clear. This explanation, of course, proves nothing for or against the existence of magnetic lag, because self-induction sufficiently accounts for the degradation effect; but, at the same time, it removes Mr. Kapp's objection as to the possible existence of magnetic lag.

The very beautiful experiment described by Prof. Perry on Thursday evening (see our report further on), by which it is possible to determine the nature and extent of the departure of an alternating current wave from the true sinusoidal form, is, of course, an exemplification of Fourier's theorem, by which any periodic function may be expressed as a sum of sines. This experiment has never been published hitherto, but Prof. Perry tells us that he has been accustomed to describe it to his pupils when explaining the theorem alluded to. The subject is one of considerable importance in the theory of alternating currents, and we may remind our readers that an elementary though complete exposition of the theorem has recently been given by Dr. Fleming in his "Notes on Alternate Currents" (*Electrician*, Nov. 18, 1887, page 28). The appreciation of this fact will remove the difficulty which found expression at the same meeting in understanding how it is that self-induction tends to smooth the irregularities of the current wave into the true sinusoidal form. For as Mr. Evershed (who argued to the contrary) correctly stated, the sine function is the only one which has a differential of the same character. Now, it is quite easy to see, physically, how the self-induced "ripples" due to the irregularities of the main current, being of similar shape but opposite sign, tend to cancel out with the very cause to which they are due, and leave, or tend to leave, a smooth curve.

The Bill of the United Telephone Company seeking powers for the erection of overhead wires within an area of 12 miles radius from the General Post Office is opposed by no less than 54 separate and distinct petitioners, who have lodged applications praying to be heard by counsel against the proposals. Amongst the petitioners are the Corporation of London, the Metropolitan Board of Works, twenty-one Local Authorities, fourteen private corporations, all the Water Companies (who object to the roads in the suburbs being dug up for the erection of posts), and, finally, all the Railway Companies in the metropolis, except the underground lines. It will thus be seen that the opposition is of a very formidable character. For our own part we are quite unable to understand in what way the present haphazard and irresponsible system can be considered

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preferable to a recognised and systematic method of stringing wires under Parliamentary sanction and restrictions. Probably, however, many of the petitioners merely seek to amend the Bill in points of detail, and are not opposed to its general principles. We trust that this will prove to be the case; otherwise we fear that its fate is already sealed. Meanwhile, the enormous suburban populations of the metropolis are denied the advantages which are now enjoyed by half the villages of Lancashire, Yorkshire, and Durham.

WE confess that we do not quite know what to make of the "House-to-House" Company. At starting, recognising the success which had been attained in the installations already at work, they carried our entire goodwill, and although we should have preferred to see their advertising operations conducted on somewhat quieter lines, we still had hopes that they would speedily settle down to a steady and successful career, even though they did not immediately undertake to light the 27 provincial towns and 35 districts of the metropolis for which the advertisements assured us that "applications had been received." When, quite recently, the Board was strengthened by the accession of one of the most practical and capable engineers of our acquaintance, our anticipations of the speedy adoption of a sound and sensible policy were greatly strengthened. But on the morrow of this event a prospectus is issued containing announcements which we cannot profess to approve of. We are at loss to understand —seeing that the company was to hold no patents—on what grounds the sum of £5,000 (besides 100 founders' shares) is paid to Mr. ROBERT HAMMOND. If it is in consideration of his "gratuitous" services as managing director for two years—which, however, the wording of the prospectus seems to disavow—we are disposed to think that the shareholders would do better in the end to appoint some less important personage to that office. However, as the company is now afloat we shall continue to hope that its technical advantages will carry it through, in spite of the difficulties with which, as it seems to us, it has become somewhat gratuitously handicapped.

PROBLEM: It is required to determine whether an incandescent lamp (found burning) is run from an alternating or a continuous current, no electrical test to be made, and the circuit not to be interfered with. Solution (by Prof. S. P. THOMPSON, before the Physical Society): Take a hand-mirror and "waggle" it in front of the lamp; with an alternating current the filament as seen in the mirror will, as a general rule, undergo a periodical change of brightness which corresponds *not* to the current period, but to the revolutions of the armature. The fact that glow lamps fed with alternating currents sometimes flicker visibly to the naked eye has long been known. The explanation was first given by Prof. THOMPSON, in a lecture delivered at Finsbury College, a few weeks ago (see *Electrician*, Dec. 2, 1887, page 83). The effect is due to an inequality in one (or more) of the pole-pieces *combined* with a dissymmetry in the armature windings. A little consideration will show that neither of these causes is efficient in itself, but that their combination necessarily leads to the result described. Moral: In building alternating-current machines, special care should be taken to make the machine symmetrical in every part.

THE inhabitants of Roker, somewhere in the north of England, are said to be very indignant at the action of the district postmaster in causing to be closed a telephone call station which had established itself in the local post office. We are sorry for the inhabitants; but not so surprised as they seem to be. The incident is an example of what the POSTMASTER-GENERAL himself describes as the unsatisfactory state of affairs subsisting between his department and the telephone companies; but, except in its tendency to bring them to a crisis, it is hard to see how pushing telephonic enterprise into the very premises of the Post Office can help to mend matters. The local newspaper compares the action of the postmaster with that of the dog in the manger. The comparison would be fairer if horses were substituted for dogs: whereupon it will readily be seen that the Government hack is entitled to defend his stall and his hay against any intrusive steed that may desire to share his quarters. Surely there is room enough for the telephone companies' operations without needlessly provoking such contests as these.

MR. SWIRE SMITH is a great authority on technical education; but his paper, the other evening at the Society of Arts, was, it seemed to us, marred by the advocacy of some rather questionable projects as well as by some conspicuous errors in argument. Commencing with the admission that no systematic technical schooling has existed in this country until recently, he proceeds with his recommendations as if the industrial supremacy of England had long since departed; whereas it would be nearer the truth to say that her decline dates from the time when we abandoned the old methods of industrial training in favour of those new ones which are to be promoted by Technical Education Bills. Again, it is admitted that foreign artisans have hardly any leisure at all, and are very poorly paid compared with our own workpeople; yet it is argued that foreign rivalry is due to the time devoted to technical education, and that we ought to give it to Englishmen free of cost. On both these points we are profoundly sceptical. Our belief is that in a general way the genius can always take care of himself, and that if the ordinary run of artisans will not spend a little of their earnings and leisure to obtain it, technical instruction will be thrown away upon them.

IT is rather hard to discover any measurable public convenience that will be served by the establishment of telegraphic money orders. Some very elaborate precautions, out of proportion to the benefit conferred, will have to be taken to prevent the abuse or fraudulent use of the system; and we rather suspect it will give a new impulse to ready-money betting at race meetings. This may not greatly accentuate the evil, but it is not worth while to go out of our way to add a new attraction to the profession of racing tipsters, whose telegraphic remittances "till the very moment of starting" will be as good as hard cash in the ring.

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OUR contemporary, *La Lumière Electrique*, contains an interesting paper by M. GASTON PLANTÉ upon the electrical phenomena which have been observed to precede or accompany shocks of earthquake. M. PLANTÉ cites a number of very interesting observations, but he has overlooked the highly remarkable instance chronicled in *The Electrician* of June 3rd, 1887, in which a telegraph clerk at Nice, who had his hand upon the instrument at the moment of the disastrous earthquake which devastated the Riviera, felt a most severe *electric* shock. M. PLANTÉ holds the opinion, in which most physicists concur, that earthquakes are, or may be, due to a variety of causes, amongst which electricity, as a rule, plays only a secondary part; he thinks, however, that in some cases, electrical disturbances may be a primary cause, though he does not venture to suggest in what way such an action may take place.

EXCEPT to remind us of the vicissitudes which the electric lighting industry had to encounter at the beginning of its career, the action brought by the Faure Electric Accumulator Company against M. PHILIPPART—judgment upon which was delivered last Monday in favour of the plaintiff company—has very little interest for us now. But no one can read Mr. Justice HAWKINS'S summing up and judgment without coming to the conclusion that the company's affairs were curiously managed, and by curious people—one of whom, for example, sought to repudiate a Board meeting resolution which he himself was mainly instrumental in passing.

A CORRESPONDENT writing to a provincial contemporary utters the following well-meant protest against the use of the grandiloquent term "installation":—

"Sir: It is curious to note how, whenever an account is given of the adoption of the electric light in any town or building, it is said that it has been 'installed' or that an 'installation' has taken place. Hitherto this term has been confined to the assumption of their duties and privileges by such high dignitaries as bishops, deans, or Knights of the Garter. Or, again, Cabinet Ministers or other great functionaries are said to be installed in office—the term having been etymologically derived from the fact of a special seat or stall being occupied by the office holder. But when this term is applied to the fixing in its place of a mere physical apparatus, is it not an abuse of language? Why should we not as well talk of a great installation of water having taken place when some new waterworks have been completed in a town? Indeed, if this sort of thing goes on we may expect to find it announced, in the case of a gentleman refurnishing his house, that 'the installation of the curtains was entrusted to Messrs. Smith and Co., whilst that of the bells was ably carried out by Messrs. Jones.'"

For our own part we should infinitely prefer the Anglo Saxon equivalent, "job." Mr. W. H. MASSEY, Electrician-in-Chief to Her Majesty the Queen, recently assured us that he never uses any other expression.

Vienna.—The western railway station is to be lit by MM. Ganz and Tarsa.

The Phœnix Fire Office Rules.—The twelfth edition of these rules was issued this week. No important change has taken place since the last issue.

The West Indian Cables.—The cable between St. Vincent and Barbadoes is now repaired.

United States Government and Submarine Cables.—A telegram from Washington states that the House of Representatives has passed the Submarine Cables Protection Bill.

Lighting of Lord Salisbury's House.—During the recess Lord Salisbury has had electric lighting introduced into the saloon and in the dining room of his house in Arlington-street.

Versailles.—A project is on foot for lighting the streets of Versailles by electricity, the idea being to transmit current from Marly. It is understood that Oerlikon dynamos will be employed.

Grenade-sur-Garonne.—This is a small place of 4,000 inhabitants, but a central station providing light for 500 lamps has just been opened here. The contractors were MM. Bonnet and Jongla.

The Electric Light on the Madras Railway.—It has been decided to employ electricity for lighting some of the carriages on the Madras Railway shortly, and for this purpose a provision of 15,000 rupees has been made in the Budget for the coming official year.

The Italian Telegraphs.—The Wheatstone automatic apparatus has recently replaced the Hughes instrument upon the line between Rome and Palermo, and also between Naples and Palermo. The line between Paris and Rome is now worked by the Baudot system.

Bournemouth.—On Wednesday evening Mr. Lynd delivered a lecture at Bournemouth on the electric light, with special reference to the storage system. The lecture was illustrated by a number of experiments, in which great interest was taken by a large and appreciative audience. A temporary installation was fitted up for the occasion by the Electrical Power Storage Company, of London.

Errata.—In Mr. Tomlinson's article on "The Thermo-Magnetic Properties of Iron and Nickel," p. 384, the following errata occur:—Heading of the fourth column of the table, instead of divided by $\frac{\Delta M_p}{\Delta t}$, read divided by 20, $\frac{\Delta M_p}{\Delta t}$. Heading of the fifth column, instead of $+M_p$ read $\times M_p$. In the 19th line of the second column of the page, 560°C. should be 650°C.

Fire Alarms at Portsmouth.—In our last issue a note appeared which was headed "Fire Alarms at Bristol," and was derived from a cutting taken from a Bristol paper, and sent to us by a Bristol correspondent. We now learn, however, that the statement referred to the erection of some fire alarm posts by the West of England and South Wales Telephone Company at Portsmouth, not Bristol, though there was nothing in the original to show this.

Electrical Engineering Football Club.—Notwithstanding the inclemency of the weather, there was a large assembly at the Prince's Hall, Piccadilly, on Friday evening last, the 24th ult., where a most successful dance, under the auspices of this club, took place. A programme of twenty dances (seventeen of which were waltzes) was got through just at the "wee sma' hour ayont the twal," general satisfaction with the band, stewards, &c., being freely expressed.

The Seel Lamp.—The "Seel" incandescent lamp has recently been attracting a good deal of attention in Germany. Like the "Khotinsky" the method of manufacture is kept

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secret, for reasons easily guessed at. The lamp is made in all candle-powers up to 300, and the large lamps are classed as taking only 2 watts per candle-power. Our readers will not need to be reminded that "watts per candle-power" is the equivalent of bread per loaf when the weight is unknown.

The Electric Lighting Act, 1882.—In the House of Commons, in reply to Mr. Barclay, Sir M. Hicks-Beach said:—Since the passing of the Electric Lighting Act 59 provisional orders and five licenses have been granted to companies, and fifteen provisional orders and two licenses to local authorities. The Board of Trade are not aware of any cases in which the powers obtained are now being exercised. It is not possible to express an opinion as to the reasons which may have led to this result within the limits of a reply to a question. A Bill to amend the Act has been introduced in another place, on which the views of the Government will be stated and issues fully discussed.

Lighting of ss. "Ocean."—The trial trip of ss. "Ocean" took place on Friday last. The vessel was built by Messrs. Russell and Co., Greenock, for carrying petroleum in bulk, and is lighted throughout with electric light; there are fifty 20-c.p. Swan lamps distributed over the ship, including signal lamps, masthead, and anchor lamps. A 50-light Clyde dynamo is employed, which was manufactured and supplied by J. H. Carruthers and Co. The whole installation has been fitted up under the personal superintendence of Mr. James Campbell. On the installation being examined and tested, it was found to the entire satisfaction of the owner, and Mr. Flannery, of London, his consulting engineer.

The Foucault Pendulum Experiment.—A simple method of rendering visible the deviation of the Foucault pendulum has recently been devised by Mr. Campbell. The bob of the pendulum is replaced by a permanent magnet of a cylindrical form placed with its axis coinciding in direction with the suspending wire. On a point vertically beneath the centre of suspension is swung horizontally a light bar of some magnetic material, carrying a mirror, from which is reflected a beam of light. On putting the pendulum in vibration in the vertical plane which contains the bar, the latter follows the deviation of the pendulum, which is thus rendered very visible by the corresponding reflection of the luminous beam.

Exeter.—At the conclusion of a lecture on electric lighting delivered last week by Mr. Wharton at the Victoria Hall, Exeter, and which was presided over by the mayor, the following resolutions were unanimously adopted:—"That in view of the great satisfaction given in the lighting of Exeter streets by electricity, this meeting is of opinion that it would be to the interest of the city, and add to its attractiveness and prosperity, if the public streets were permanently lighted by the system of arc lighting now in use." "That it is the desire of this meeting that a local company should be at once formed for the purpose of supplying Exeter with the Thomson-Houston system of electric lighting for public and private use."

Earth Currents during the Recent Solar Eclipse.—A diurnal period of variation in the intensity of earth currents has long been recognised, but it has not yet been settled whether the action is due to direct electro-magnetic induction from the sun, or whether it is an indirect result of the change of temperature. We learn from the Moscow *Technik* that in order, if possible, to throw some light upon this question, careful observations of the earth current upon the Vladivostok-Nagasaki cable were made during the recent eclipse of the sun. It appears that up to the commencement of the eclipse the current was of the normal value, but it then commenced to *increase* until during the period of totality it had become twice as large, after which a decrease set in, and at the end of the eclipse it had again attained the normal value.

The Electric Lighting of the Leeds Fine Art Gallery.—The Electric Lighting Committee of the Leeds Corporation met yesterday to consider what form of power should be employed for driving the dynamos in connection with the electric lighting of the Leeds Fine Art Gallery. After discussing the respective claims of steam, gas, and compressed air as motive powers, it was decided to adopt the latter, as being generally more suitable for this particular purpose; as getting rid of risk from fire; as obviating the use of fires, boilers, and long chimneys, and as being of service in connection with ventilation. It was therefore decided to accept the offer of the Compressed Air Company to supply compressed air, and also to furnish five 25 horse-power engines and a meter, at a rental of £50 per year for three years. The Town Clerk was instructed to prepare an agreement embodying this arrangement, and a meeting of the committee will be held early next week, when the terms will be duly subscribed to.

Tests of Electrical Welding.—Prof. A. E. Dolbear writes to the American *Engineering Record* as follows:—"I have had made nearly a hundred tests of the tensile strength of electrically-welded bars of iron, steel, and other metals. The results were of such a character that I can state positively that with Thomson's welding process it is possible to weld both wrought iron and steel so that the weld is as strong as the same cross-section in another part of the bar; that the appearance of the fracture is fibrous for iron and generally granular for steel, the strength of this granular steel being on some samples as high as 125,000 pounds per square inch; that the process is such that the welding is homogeneous from necessity. I had a number of bars welded by an expert blacksmith, and a number of similar ones by the electrical process for comparison, with the result that the electrically-welded bars were much stronger than those welded by the ordinary process. The bars were of various sizes, up to an inch and a half for iron, and three-fourths of an inch octagon steel."

Glasgow City Bazaar.—The lighting of the Glasgow Bazaar and City Hall with the Thomson-Houston system (arc lamps) was completed and formally inspected by the members of the Town Council on the 14th inst. Everything was satisfactory. The engine, which is a 16 horse-power compound, was made by Robey and Co., Globe Works, Lincoln, for Mr. Miller, the agent to the Thomson-Houston Co, at Glasgow, and was running under brake from 9 a.m. till 4:45 p.m., when it was stopped to put the machine belts on, and at 5 o'clock was started again for the official test of six hours, with the full load of 34 lamps. At 11 o'clock all bearings were quite cold. One half the lamps (*i.e.*, those in the bazaar) were thrown off, and the remainder were kept going till 3 a.m. The engine, therefore, had a continuous run (except the 15 minutes for putting on belts) from 9 a.m. one day until 3 a.m. the next. The oiling arrangements are most satisfactory, and there would appear to be nothing to prevent continuous runs for an indefinite time. The governor acted perfectly when the half load was thrown off, and there was no perceptible change in the engine speed.

The Electric Light at Civil Service Stores.—Speaking at the annual meeting last Monday of the Civil Service Co-operative Society (the Haymarket Stores) the chairman,

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Mr. Charles J. Cox, stated that the electric light had been partially introduced into the stores. They had found it of very great advantage. Many of the articles they sold were liable to injury from the fumes of gas, and those articles were now protected by the use of the electric light. If it should prove thoroughly satisfactory they proposed to extend the use of the electric light throughout their buildings.—Mr. Bannister, the chairman of the Civil Service Supply Association (of Queen Victoria-street, City, and of Bedford-street, Strand), stated at the annual meeting of the association on Tuesday that the increase of about £1,500 in the fixtures was attributable to their having adopted the electric light at Queen Victoria-street. The light was now used on almost every floor, and they had been compelled to put it in the basement. They were now working such a large number of men there that it was necessary, for the purposes of health and safety, to use the electric light wherever they could instead of gas.

Electric Traction in Austria.—The Vienna correspondent of *Industries* says that Herr Fischer, a civil engineer of that town, has obtained a concession for an electric railway between Vöslau and Rauhenstein, near Baden, and from there to Leopoldsdorf. The length of the line being considerable, Herr Fischer will probably use storage cars; Julien accumulators are now being tested in the Electrotechnical Institute, and a trial of these cells for tramway work in competition with Reckenzaun cells will shortly take place. A central station for the supply of electricity has recently been erected at Neuhaus, in Bohemia. The contractor is Count Czernin, a landowner in that district, and he has arranged for the supply of light to the Commune for 20 years. Power is obtained from a turbine, and there are at present two dynamo machines installed. The distribution is on the three-wire system with feeders. All the leads are carried on poles overhead. The streets are lighted by 85 16 candle-power glow lamps, and in private houses there are at present 365 lamps fixed, but the demand is constantly increasing. To provide against breakdown a battery of 1,000 storage cells is now being laid down.

Accident to Overhead Electric Light Wires in New York.—According to a New York paper an overhead electric light wire in that city recently became red hot. The account proceeds as follows:—"The wires belonged to the plant of the United States Electric Light Company, and ran on poles on both sides of Sixth Avenue. At 8 o'clock the numerous street lights which the wires operate were brightly burning. Suddenly a spark of fire appeared on the branch wire which operates the arc light in front of some grocery store. In an instant the glow had spread to the main wire, which for a distance of 100ft. or more emitted a dazzling brilliancy. The illumination speedily attracted an immense crowd. This crowd continually increased in size, and the matter was promptly reported to the police station. In the meantime the avenue was blocked, and the police had great difficulty in keeping the crowd at a safe distance from the glowing wires overhead. To increase the excitement, the wire on the opposite side of the street also burst into flame. One excitable man ran to the engine house in Tenth-street, and called for assistance. Several firemen responded; but, of course, could do nothing. A cross-bar on one side of the poles caught fire from a tongue of flame; but beyond the injury to the wires and pole the loss resulting from the accident will be slight. Linesmen of the electric light company, who handled the blackened wires as soon as they were cold, decided that the snow and ice had in some way formed a connection between the oppositely-charged wires and completed the circuit."

The Indian Telegraph Department.—The following particulars relating to the progress of Indian telegraphs are given in the Administration Report for 1886-7:—The Indian telegraph system embraces every military station and every town of importance throughout the length and breadth of the vast Indian Peninsula, including the territories under Native Chiefs and Princes, as also military stations and towns in Lower Burma and most of the military posts recently established in Upper Burma, and on the 31st March, 1887, there was a total post mileage of 30,034 miles, with a total length of 86,890 miles of wire, in addition to 196 miles of cable connecting India with Burma. During the year under review the post mileage was extended by 2,524 miles, and the length of wire by 5,410 miles. The number of telegraph stations open to the public on 31st March, 1887, was 2,389, of which about 50 per cent. have been opened since April, 1883. There are two classes of messages, State and private, and we give below a statement of the number of each class during the year, with their value:—

	Number.	Value Rs.
State Inland	452,277	16,20,626
Private Inland	1,683,753	18,17,798
State Foreign	6,898	78,494
Private Foreign	373,893	13,13,321
Total	2,516,826	48,30,239

These totals represent an increase in the number of messages sent, as compared with the preceding year, of 226,888, and of Rs. 8,69,187 in the value of the messages sent.

Remarkable Discharge of Atmospheric Electricity.—A correspondent writes as follows:—"A most violent discharge of electricity was observed on board the Danish steamer 'Constantin,' coming from Newcastle and bound for Copenhagen, on Friday morning, February 10th, when about 160 miles distant from the English coast. Although the thermometer was at freezing point thunder and lightning began some way off, between 4 and 5 o'clock a.m. At about 6 o'clock a tremendous report was heard, sounding like thunder, and the captain describes the appearance of the vessel as if it were shrouded in a mass of bright red flames, which lit up the surrounding waves. The phenomena was all the more surprising as the thunder and lightning appeared to be at some considerable distance from the steamer, and it could not be compared to an ordinary thunder-clap and lightning flash, being far too violent and no regular flash of lightning being seen. The shock was so great that several men in various parts of the ship were knocked down, and the first engineer was under the impression that a boiler explosion had taken place. The whole thing only lasted a moment, but it was attended by a violent wind, and St. Elmo's lights were seen on the tops of the masts and elsewhere. On arriving at Copenhagen the captain found his suspicions confirmed of alterations having taken place in the deviation of the ship's compasses. The alterations were greatest on S.S.E. and N.N.W. courses, where the deviation, from having been 7 degrees westerly, had become 5 degrees easterly. The vessel was, when the electrical discharge took place, steering E. to N."

Communication with Lighthouses and Lightships.—Referring to the resolution passed by the Associated Chambers of Commerce in favour of telegraphic communication with lightships, *The Times* says:—"The motion introduced by Mr. Bayley, of Plymouth, for the connection of coastguard stations and lighthouses and lightships with the general telegraphic system of the country, and thus with each other, was well deserving the favourable reception which it met. Mr. Bayley's case is a very strong one, and the need to which he refers is so

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great and so obvious that it will be a surprise to our readers to learn what imperfect provision has been made for it. There are at present only a few signalling stations, belonging not to the public, but to Lloyd's; and, apart from these, the gun and rocket are the only available signals of distress. These signals may not be heard, or may not be rightly understood. Precise they can very seldom be. The lighthouse or lightship may see distinctly what has happened, or what want is seeking to be relieved, but it has no adequate means of passing on the information. There have been plenty of instances serving to demonstrate the pressing importance of not suffering things to remain as they are. The steamer 'Nordstern' ran on shore under the Start lighthouse, and was there seen at midnight. From want of communication between the Start lighthouse and the points at which help was to be had, it was four and a half hours before any help came, and 10 hours before a lifeboat, only five miles away, arrived Again, when the steamer 'Soudan' was wrecked, close to the coastguard station at Hope Cove and 15 miles from Plymouth, it was seven hours before the news reached Plymouth, and 12 hours before a tug came to her help. Such cases as these are decisive, but they do not make up the whole of what may be said. As regards coast defence, the matter is of an importance which it would be hardly possible to exaggerate. The want to which Mr. Bayley refers was felt practically in the course of the late jubilee manœuvres, and in the event of war it would no less certainly recur with disastrous results at a time no longer of play, but grim earnest. Mr. Bayley has done his part. He has brought the subject prominently under notice. It remains for the responsible authorities to deal with it as the case demands."

Electrolytically-Formed Copper Pipes.—According to *Engineering*, Mr. W. Elmore, of Cockermouth, has at last succeeded in obtaining electrolytically a deposit of fibrous copper. By this method, says our contemporary, such an article as a steam pipe can be produced without weld or joint, and having a tensile strength from 50 to 100 per cent. in excess of first-class brazed pipes. Further, this result can be attained with the use of a very inferior quality of copper, and at a cost which will enable the electrolytically made article to compete in the market with the customary varieties. Of course there is nothing new in depositing copper in a tubular form; but hitherto such metal has been too brittle to render it reliable for use in circumstances under which it is exposed to great stress. For copying engraved plates and for the rollers of calico-printing machines deposited copper has been used with great success, and when it has been thrown down very slowly it has been possible to produce very satisfactory qualities of metal for these purposes. The novelty introduced by Mr. Elmore, however, lies in breaking down the crystals almost immediately they are formed, and pressing them out into a fibrous form in which they are interlaced and matted together. To this end the iron core or mandrel on which the metal is deposited is kept constantly rotating in the bath, and an agate burnisher is slowly moved backwards and forwards lengthwise of the cylinder, as if to cut a screw thread upon it. The speeds are so arranged that a layer of copper seven-thousandths of an inch thick is deposited between each reciprocation of the burnisher. When the required thickness has been attained the mandrel is lifted out of the bath and placed in a vessel supplied with superheated steam. In a few moments the expansion of the copper detaches it from the iron, and the shell can be stripped off. Pieces cut from such tubes have been submitted to breaking tests by Messrs. Kirkaldy and Co., Prof. Kennedy and Prof. Unwin, and have broken at strains varying from 27 tons to 41 tons per square inch, with an extension varying from 5 per cent. to 7½ per cent. in a length of 10in. The metal can be worked under the hammer most easily, and can be drawn, bent or compressed without annealing and without any tendency to crack. Specimens polished and submitted to the microscope show that the electrolytic metal has a perfectly compact and homogeneous structure, while drawn copper is a honeycombed mass of crystals, only connected together at points. The success which has attended the experimental stage of Mr. Elmore's process encourages the belief that absolute security from burst copper steam pipes can be secured in the future, and that we are on the eve of being supplied with a greatly improved quality of copper for all purposes.

Electric Railway Signals.—A system of electric signalling, by means of which a signal is with facility and certainty given to the driver of an engine by indicator in front of him, has been before the railway world for some time; but although it would effectively prevent accidents in fogs, and reduce the heavy cost at such times for signals and fog signalmen, it has not been taken up by our railway companies. This is partly due, says the *Engineer*, to the fact that as each engine must be fitted with a small apparatus, it would be necessary for the complete safety against accident that every engine running on a line, to whatever company it may belong, should be so fitted, and hence for some lines the several companies would have to agree to its simultaneous adoption. The invention is the subject of patents held by the Electric Signal Company, and it has been tested with success on the Belfast Central Railway and on the Penally and Tenby line. The following is from a report of Dr. J. Hopkinson, F.R.S., on the system, which is Enright's patent:—"On August 22nd I visited Tenby and examined the apparatus put up by Mr. Enright at Penally Station, and on the line between Penally and Tenby, and I fully tested it in operation. The apparatus has primarily two purposes to fulfil, first, to enable the signalman to communicate with the driver of a train in motion electrically without the use of detonating signals or distant visual signals; second, to record the passage of all trains along the line automatically. I carefully verified the working of every part of the apparatus, both from the point of view of the signalman at the station and from the point of view of the driver on the locomotive. In my presence every part of the apparatus performed perfectly; the signals on the locomotive were unmistakable, and the contacts were properly recorded upon the drum at all speeds of the locomotive up to fifty miles per hour, the maximum it was practicable to obtain. In the experiments I witnessed at Tenby Mr. Enright's apparatus worked most satisfactorily, and it was evident that he had employed much skill and thought in working out the details of his invention, particularly in securing regularity in the electrical contact between the locomotive and the road. The *à priori* arguments in favour of electrical signals, instead of, or in conjunction with, the ordinary semaphores, are strong, but the advantage in their use would appear to be exceedingly great as superseding the barbarous system of detonators now used in fogs, and for this purpose they might be used in conjunction with the ordinary visual signals, and so be subject to the existing interlocking apparatus on which safety so much depends. The expense of introducing Mr. Enright's system in this way could not be very great." The fact that the system is not in use yet would appear to be due to its being insufficiently represented before the railway companies; but as the patents are, we understand about to be sold, this defect will perhaps be removed.

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THE RISE AND PROGRESS OF TELEPHONY IN THE UNITED KINGDOM.

(Continued from page 338.)

In our last chapter we stated that early in 1885 the United Telephone Company completed an arrangement with the Post Office for the transmission of telegrams to and from the central telegraph office and the houses of the company's subscribers. It will be of interest to trace briefly the steps by which this and other important concessions to the telephone companies were obtained from the Post Office.

We have already given an account of the suit brought against the United Telephone Company by the Post Office, on the ground that a telephonic message was a telegram within the meaning of the Telegraph Act of 1868, the result of which was a judgment against the company. The United Telephone Company very wisely decided to accept the decision of the Court of First Instance, instead of carrying the case to the Court of Appeal, on the understanding that they would be allowed to carry on their work as licensees of the Postmaster-General. The original license granted to the United Telephone Company, as also those subsequently granted to other companies, ran from the 1st of January, 1881, for a term of 31 years, the Postmaster-General, however, reserving to himself the power to purchase, at a price to be settled by arbitration, in 1890, 1897, or 1904. Each license was granted for a particular district only, generally included within a radius of five miles, and a royalty of 10 per cent. was payable by the company to the Post Office on the gross earnings of all their exchange wires, and also of any private wires rented from them, with the exception of wires connecting two establishments occupied by the same person or firm. The permission to extend the radius was frequently refused, and when granted the Post Office usually demanded a royalty of 12½ per cent. on all wires running outside the original radius. The companies were not allowed to establish trunk lines between different towns, except upon conditions which were practically prohibitive.

Subscribers to the Post Office telephones were allowed to have telegrams transmitted to and from the post offices; but this privilege was only granted to the subscribers to the telephone companies' exchanges on the payment of five guineas per annum by each firm desiring the privilege, in addition to the ordinary tariff for the telegrams transmitted. These restrictions, as was to be expected, greatly hindered the development of the telephone system, and in the spring of 1884 a memorial was presented to the Postmaster-General, Mr. Fawcett, by the Edinburgh Chamber of Commerce asking Her Majesty's Government to grant such facilities as would encourage and develop the telephone system, without unduly interfering with the revenue of the Post Office. This was followed up by questions on the subject in the House of Commons, and ultimately Mr. Fawcett, who showed every disposition to consider the requirements of the telephone companies in a reasonable spirit, decided to request them to endeavour to come to an agreement as to the modifications of their existing relations with the Post Office which in their opinion would meet the public requirements, and to communicate the result to him in writing, as he considered that it would be desirable to give greater freedom to private enterprise by relaxing some of the conditions contained in the licenses hitherto granted.

In reply to this request the United Telephone Company, and its affiliated companies, submitted three distinct proposals, and the four non-affiliated companies likewise submitted statements of their views, which, in the main, were to the same effect, except that the latter asked for protection from competition in the towns where their exchanges were established, a proposal which Mr. Fawcett declined to entertain.

The three alternative suggestions submitted by the United Telephone Company were as follows:—

1. That each company should be allowed to carry on business within the district for which they held a license in any way they might think fit, and that in lieu of the royalty of 10 per cent. then paid to the Post Office on their gross receipts, the companies should undertake to make good to the department any loss which the local revenue might suffer from the development of telephonic communication within the district, allowance being made for the normal growth of the telegraph revenue based on the receipts of the three preceding years.

2. That the existing royalties should be reduced from 10 per cent. to 5 per cent.; that the same guarantee as that contained in the first proposal should be entered into; that the existing radius for exchange licenses, then generally fixed at from four to five miles, should be extended to fifteen miles; and that various other restrictions should be removed, giving practically the same freedom as that embodied in the first proposal.

3. That the existing royalty should continue to be paid as before, but that the other modifications suggested in proposal 2 should be made.

After careful consideration, Mr. Fawcett decided that the first two proposals must be rejected, as in the first place the acceptance of a guarantee would involve granting the local monopoly to the company then in possession, and he considered that if there were to be a monopoly it ought to be in the hands of the Government, and in the second place the Post Office would be hampered in introducing any change in their then existing telegraph tariff.

There remained the third proposal, and this, the Postmaster-General considered, offered a basis for a settlement, and the terms which he proposed and stated in the House of Commons in August, 1884, were as follows:—

1. That the Government should reserve the right either to carry on telephone business itself or to give licenses to any responsible persons to carry on such business in any part of of the country, whether any previous license had been granted for such part of the country or not.

2. That the condition that the companies should furnish the Post Office with an unlimited supply of any patented instruments used by them should be abandoned.

(We may note that great stress had been laid on this abandonment in the proposals of all the companies.)

3. That as the extension of the radius to fifteen miles asked for by the companies would involve in principle just the same objections as fixing the radius, as at present, at four or five miles, no limitation of radius should be maintained.

4. That with the abolition of any limit of radius and consequent extension of areas, the distinction between the conditions on which the companies had hitherto been allowed to use trunk and exchange wires should not be maintained, the companies being in future able to provide themselves with trunk and exchange wires alike.

5. That call offices should be allowed for the transmission of oral messages.

6. That, having regard to these concessions, and to the desirability, as far as possible, of securing simplicity of accounts between the Post Office and the companies, *the royalty of 10 per cent. then paid on gross receipts should be extended to their receipts from the private wires hitherto exempted.*

7. That the Post Office should incur no obligation to provide way-leave or to erect wires for the companies.

8. That in order to maintain the distinction between written telegraphic messages and the spoken communications made by means of the telephone, *the telephone companies should not accept or deliver any written message at any point.*

This offer on the part of the Post Office conceded in several points more than had been asked for either by the companies or the public, and was received as being, on the whole, a broad and liberal concession to an enterprise the encouragement of which was imperatively demanded by the public interest.

Strong opposition was, however, offered by the companies to the sixth clause. Colonel Raynsford Jackson, Chairman of the National Telephone Company, pointed out that the demand of a royalty on private wires would have the effect of placing the companies at a disadvantage in competition with private firms, as private telephone wires communicating only between premises occupied by the same person or firm, did not require the sanction of the Postmaster-General, and might therefore be erected by private firms without payment of the royalty.

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With respect to the eighth clause Colonel Jackson suggested that the wants of the public could be met without in any way infringing this condition, if the Postmaster-General would allow the various exchanges erected by private enterprise to be connected with the Postal Telegraph Office, and permit the subscribers to send, through wires which could be switched into operation when required, messages to the Postal Telegraph Office to be transmitted as telegrams, so that there would be no delivery of written messages by the companies, but there would be a great increase of business to the Postmaster-General through the instrumentality of the various companies' exchanges. In addition to giving subscribers the privilege of sending Post Office messages through the Postal Telegraph Office he suggested that the Postmaster-General should also, when he received such messages for the Telephone Exchange subscribers, deliver these messages to them through the exchange, the Post Office to charge their ordinary rate for the telegrams, and to abandon the annual rent charge of five guineas previously demanded from firms availing themselves of this privilege.

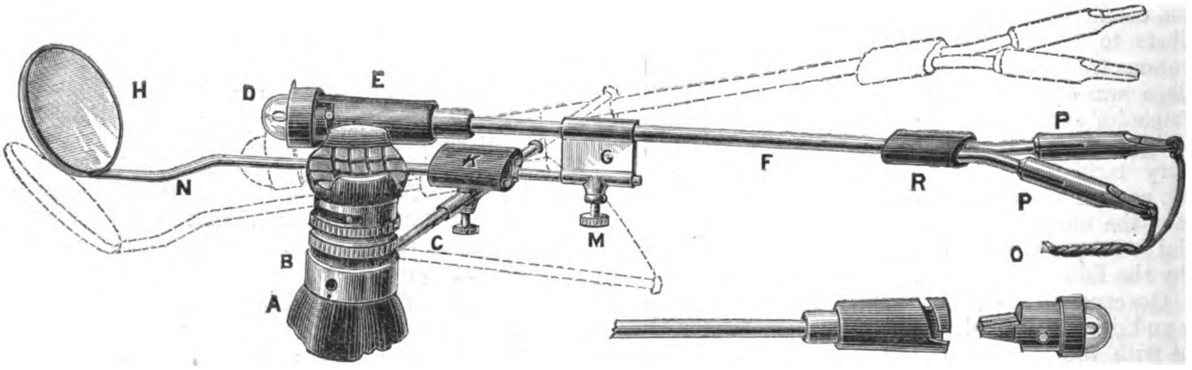
Mr. Fawcett finally decided to grant the facilities asked for, and also to abandon the claim for royalties on private wires hitherto exempt from them. His death occurred in November, while the negotiations with the companies were still in progress, but they were carried on on the same lines by his successor, Mr. Shaw-Lefevre, and, with the above mentioned modifications, Mr. Fawcett's proposals were definitely adopted.

(*To be continued.*)

VESEY'S ELECTRICAL ODONTOSCOPE.

We illustrate herewith an electrical appliance, designed by Mr. Vesey, for the use of dentists in stopping teeth. Mr. Vesey's electrical laryngoscope, which was described and illustrated in *The Electrician*, 21st January, 1887, page 244, is now in use all the London hospitals, and by many of the leading surgeons, not only in this country but also on the Continent. The illustration (Fig. 1) together with the lettered description will make the details perfectly clear. Fig. 2 shows the incandescent lamp slipped out of the socket, in which it is held by a bayonet joint; it will be seen that the method of attachment is extremely simple. The filament is joined to two small platinum wires which lie flat against the wooden holder, and when fitted in to the socket are pressed against the insulated platinum jaws.

The battery used is a 4-cell Victoria Leclanché, made for Mr. Vesey by the General Electric Company, and is found to answer its purpose admirably. The lamps are made by the Edison Company, and the instrument is made by Messrs. Weiss and Son, of Oxford-street.



A Ordinary dentist's gag, fitted with the usual spring adjustment for various mouths.
B Revolving collar, with arm C attached.
D Incandescent lamp.
E Bayonet joint, to release lamp instantaneously.
F German silver tube sliding through spring clip G.
H Mirror, either plan or magnifying.
M Set screw to clamp G at any point on N.
N Sliding rod holding mirror.
O Flexible cord to battery.
PP Spring terminal to flexible cord.
R Ebonite to receive tube F, and terminals PP.
K Ebonite supporter for rod N, and sliding on rod C.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER VIII.—*The Calibration of Current Indicators.*

(*Continued from page 410.*)

82. It will be noticed that the instrument is very unsensitive above 70 degrees and below 10 degrees—that is, considerable change in the current strength is necessary to produce appreciable change in the deflection; but at angles between 20 and 50 degrees the instrument is most sensitive. The steeper the incline of the curve, the more marked will be a change of deflection for a change of current.

The value of any current may now be found by reference to the curve; thus, if 12 degrees deflection was observed the corresponding current could be found by placing the edge of a flat ruler at number 12 on the vertical degree ordinate, and the edge of the rule being horizontal would cut the curve in some point. Marking this point lightly with a pencil the rule would be turned vertically in a line from the point on the curve to the horizontal ordinate. This would cut the latter at 10 milliamperes, which is the required current. It should be mentioned here that practical working curves are usually about four or five times the size of the one in the figure; in fact, the larger the scale they are drawn to and the more observations taken from which to plot them the better.

83. This curve is seen to exhibit no "straight line law" or proportionality between currents and deflections except, perhaps, up to 10 degrees—that is, every scale degree movement of the needle does not represent an equal increase of current. As simple examples of proportionality between indications and scale degrees, there might be cited the Salter's balance, where every scale degree movement of the pointer means an equal increase of weight suspended to it; or the steam-pressure gauge, in which every equal scale division means equal increase in steam pressure; or the thermometer, whose scale divisions are equal, and mean equal rises in temperature; or the ordinary clock, whose dial is divided into twelve equal parts, each of which mean equal intervals of time. If we were to plot the relation between degrees deflection, and weights in the spring balance, or between divisions deflection, and pressure in the steam gauge, or between divisions rise of mercury, and temperature in the thermometer, or between movements of clock hand and intervals of time in the ordinary clock, precisely in the same manner as the readings are plotted for the detector in Fig. 48 *ante*, we should get a straight line instead of a curve, showing absolute proportionality between the indications and degrees of scale. This straight line law or absolute proportionality is very desirable in instruments used in the measurement of large currents used in electric lighting, and has been very successfully carried out by

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Profs. Ayrton and Perry in their ammeters, or current measurers, in which the divisions through which the needle is deflected are made equal to each other and correspond to equal increments in the current strength throughout the whole of the scale. Messrs. Walmesly and Mather have devised a galvanometer whose deflections follow the proportional law up to about 50 degrees. These instruments will be referred to again in detail, when the different kinds of galvanometers are examined.

84. If now the indicator to be calibrated is of the horizontal type, we should expect to find the needle move round a large number of degrees for a very small current, since the horizontal mounting of the needle, whether by a pivot or by a silk fibre suspension, admits of greater sensibility. One or two cells would then furnish the maximum current required, the largest deflection being obtained with the battery connected direct to the instrument, and the deflection being gradually reduced by the addition of extra resistance to the circuit. We shall in this example also select cells (such as secondaries or large size primary cells) of low resistance, negligible in comparison to the resistance of the instrument coils

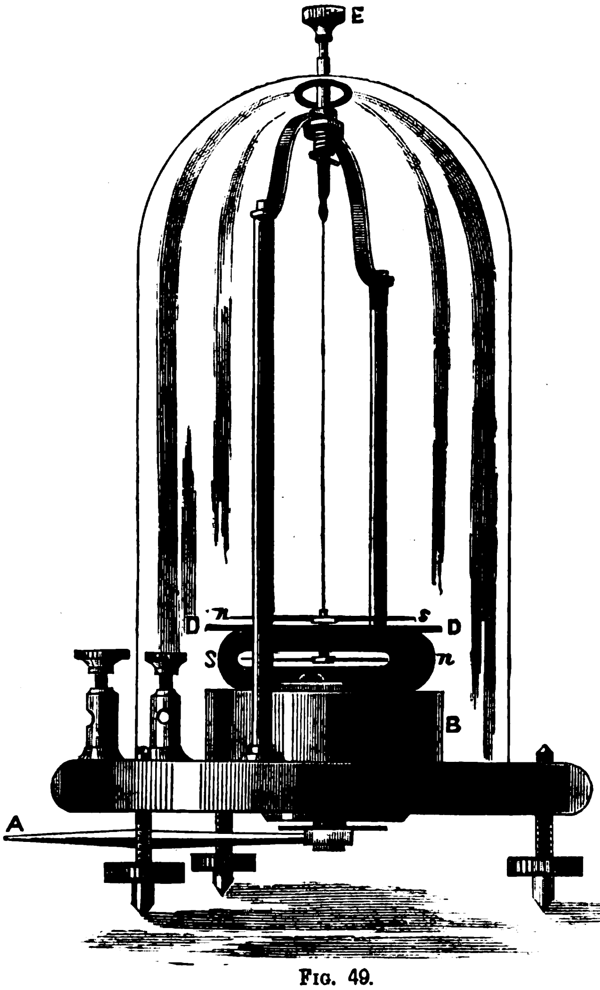

FIG. 49.

A curve taken in this way of the astatic instrument shown in Fig. 49 is here appended. The two needles marked *n s* in reverse ways may be seen in the figure, suspended by a silk fibre, one being inside and the other outside the coils forming the astatic system. To set the instrument it must be turned round till the needles are parallel to the plane of the coils, which will be the case when the top needle points to zero on the graduated dial D. This can very conveniently be effected without shifting the base of the instrument when once levelled by moving the coils alone, these being attached to a hollow wooden base, B, capable of being turned about the centre by means of the handle A through an angle of about 60 degrees. The base B contains a sufficient length of flexible wire, spirally wound, to admit of this movement of the coil while it is connected permanently to the two terminals. It is important to see that the lower needle does not touch the interior of the bobbin during any part of its movement, and once the needles are perfectly still, this can be tested very well by moving the handle A right and left through its full range, which should not cause the slightest movement of the needles. If it does, the interior of the bobbin should be looked through to see if the lower needle is too high or too low, and its height can then be adjusted as required by raising or lowering (not screwing round) the suspension head E, to which the silk fibre is attached.

85. The instrument, after being "set" as described, should be connected to a box of standard resistance coils A, and a low-resistance cell, as shown in Fig. 50. The higher the resistance of the coils in the instrument the more margin may be allowed for the resistance of the cell while considering the latter as a negligible quantity—that is, if the coils were, say, 1,000 ohms, as high a resistance as 3 or 4 ohms in the cell would be practicably negligible. Horizontal instruments are usually wound to resistances from 500 to 1,000 ohms. If there is no very low-resistance cell available, such as a primary battery with large plate surface in use for lighting, or a charged accumulator, or a large size Daniell or Fuller cell, three or four cells may be connected together in multiple arc—that is, all the zincs together to form one terminal of the battery, and all the coppers or carbons together to form the other. This will then act as one cell of as many times the amount of plate surface as there are cells connected up, and the internal resistance will be diminished in proportion to the number. Thus, four cells in multiple arc would have one-fourth the internal resistance of one cell, five cells one-fifth, and so on, while the E.M.F. of the combination,

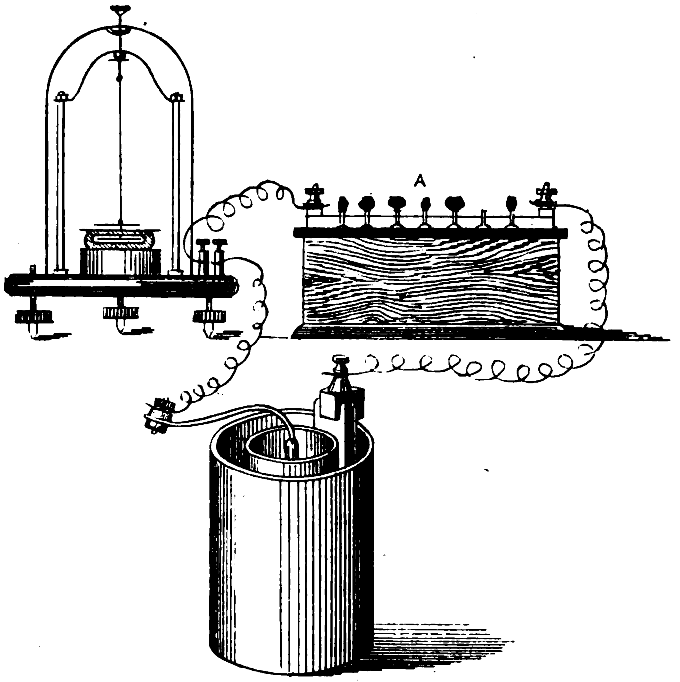

FIG. 50.

in this manner, of any number of similar cells would be the same as that of one.

(*To be continued.*)

RENEWING TELEGRAPH AND TELEPHONE WIRES.

The frequent interruptions caused by earths and contacts during renewal operations have at all times been a source of much annoyance to telegraph engineers. Considerable attention seems, however, to have been given to the matter lately, and various appliances have been designed to avoid stoppages from this cause and to maintain uninterrupted communication while new wires are being run.

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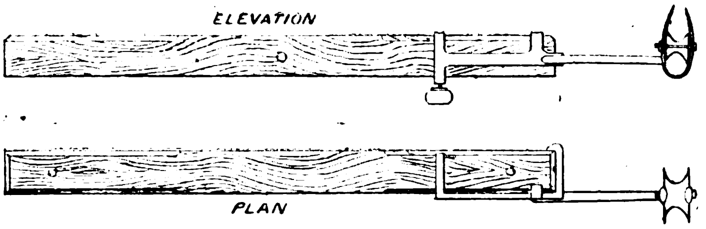
Particulars have been furnished us of another appliance designed and patented some time ago by the Caledonian Railway Company's engineer, Mr. Dunn, and excellent results are said to have been obtained by means of this tool. Its use, instead of retarding work, as might seem at first sight to be the case, is said to facilitate the operations to such an extent that at least 20 per cent. more can be done in the same time. The runner, as shown in the adjoining figures, is attached to the arm by transverse jaws and an under pinching screw, and the outer end carries a free pulley, over which the new wire is run. The pulley is a special feature of the tool, as it offers little or no resistance to the wire, and in drawing out enables one man to do the work hitherto done by two. The "scouring" and "skinning" which take place when wire is drawn over rough ground, or over arms against insulator bolts or other rigid surfaces, are also completely obviated, and the wire is got into position without the zinc coating being broken or in any way impaired.

The method of using is as follows:—One runner is attached to a long arm on each pole along the section over which a coil of new wire will run. The wire is then drawn out over the runners, and as those project it is kept clear of the standing wires on the poles. When drawn out, the wire is viced up on the runners and exchanged with the old wires, after which the latter is cut down. The whole process is gone through without the new or old wire getting foul of any other wire on the poles. It will be apparent that it is much easier to lift the bight of the wire on to the runners as it is being drawn out than to thread the wire over the arm between the insulator and the pole, as is done under the old system.



A number of appliances had been designed and tested by Mr. Dunn, but it was found after considerable experience that the one now described is most suitable for the work. The advantages claimed are that it is light and portable, and can be quickly and securely attached without boring or cutting the arm. It provides complete immunity from interruptions and facilitates the work. It prevents injury to the anti corrosive coating of the wire, and adapts itself to the system of drawing wires out.

OUR ELECTRICAL DEFENCES.

The report of the committee appointed to consider the defence of our naval and mercantile ports has just been issued, and, as was fully to be expected, the greatest possible stress is laid upon the importance of submarine mining operations—a phrase which, it is scarcely necessary to add, is synonymous with that of "electrical defences." The report states that—"It is satisfactory to note that very great progress has been made in carrying out the submarine mining defences. In many of our ports the work is well advanced, and the committee strongly urge that, in every port intended to be defended at all, to which it is applicable, this work should be pushed forward to completion as rapidly as possible; and they are of opinion that, as funds become available, efforts should be made to complete these defences at the most important ports instead of spending small sums upon many ports. The committee consider, moreover, that steps should be taken to afford additional opportunities for practice to all those (whether belonging to the Regular or the Auxiliary Forces) who will have to take part in submarine mining operations in time of war." In view of this statement it may confidently be anticipated that steps will be taken at an early date to increase the number of Volunteer Corps for harbour defence. We have already taken the opportunity of commending this scheme to the attention of our readers (see *The Electrician*, 28th October, 1887, p. 511).

Through the courtesy of Messrs. Armstrong and Mitchell, of Newcastle-on-Tyne, we have recently had the opportunity of inspecting and experimenting upon the electrical appliances of Capt. McEvoy, which form a portion of the war *matériel* manufactured by that firm, and next week we hope to give a full and illustrated description of the apparatus, which, we may add, has not before been published.

We append a table taken from the report already referred to, which will enable our readers to judge for themselves of the importance which the electrical defence of our harbours has already assumed.

DEFENCE OF HOME MERCANTILE PORTS.

Port.	Submarine Mines.	
	Expended on submarine mining works up to 31st March, 1887 (buildings, stores, and vessels).	Required to complete submarine mining works (buildings, stores, and vessels).
	£	£
The Mersey	20,362	7,350
The Clyde	27,359	9,411
The Bristol Channel	13,639	14,451
The Humber above Grimsby	22,214	6,318
The Tyne / Sunderland	8,244	15,346
Hartlepool and the Tees	14,187	11,803
The Forth	6,937	19,163
The Tay	13,672	17,823
Aberdeen	...	Not estimated.
Falmouth	3,162	29,758
Dublin	4,359	24,891
Belfast	308	25,192
Holyhead	...	Not estimated.
	£134,443	£181,511

THE ELECTRIC LIGHTING OF THE SAVOY THEATRE.

This installation, which was the first on a large scale in which incandescent electric lamps were employed, was completed in 1881, and was used for the first time to light the theatre at the evening performance on the 10th of October of that year. The installation was carried out by Messrs. Siemens Brothers, under whose charge it has remained up to the present time, and from the beginning the lighting has been thoroughly satisfactory in every respect. The stage is at present lighted by 715 white lamps or 601 blue ones, the latter being used for the night scene in "Pinafore," now being revived at the theatre, and their number is therefore intentionally less than that of the white ones. These lamps are nearly all on one simple shunt-wound dynamo, and their brilliancy is regulated by inserting resistance in the circuit of the field-magnets, an arrangement which has the advantage of avoiding almost entirely the waste of energy resulting from the ordinary method of inserting the resistance in the external circuit. The battens which carry the stage lamps, other than the footlights, are made entirely of incombustible materials. The insulated cables, proceeding from the stage ladders which carry the lamps to be placed on the movable scenery, terminate in triple plugs which are inserted into contact pieces on the stage, and the change from white to blue or *vice versâ* is made for these, together with the other stage lights, by means of a single switch.

The auditorium is lighted by 150 lamps arranged in groups of three, supported on three-fold brackets projecting from the different tiers, and each lamp is enclosed in a ground-glass or opal shade, so that the light is soft and pleasing. The corridors, refreshment rooms, and offices are lighted by 165 lamps, and 148 are in use in the dressing rooms behind the stage. The maximum number in use at one time is, therefore, 1,178, the total number fitted being 1,779. They are all of the Edison-Swan type. The lamps are all arranged in parallel on three main circuits, one of which is in parallel with a circuit containing two arc lamps, taking 40 amperes, placed outside the theatre. The current is produced by three Siemens dynamos of the S.B. type, each capable of giving 400 amperes at 93 volts. The dynamos are driven at about 700 revolutions a minute by two Marshall port-

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able engines of 20 horse-power, and one Robey semi-portable engine of the same horse-power. These engines are capable of working up to about 180 horse-power, of which about 150 are usually utilised. The present engines and dynamos are merely in temporary use until the permanent machinery for lighting the Savoy Mansions, as well as the theatre, has been erected. They are at present placed in the basement of these mansions, which are now in course of construction.

A very convenient feature of the installation is the placing of the switch room on a corner of the stage, the whole of which it commands, so that the engineer-in-charge has no difficulty in knowing the exact moment when any set of lamps have to be raised or lowered, or when a change of colour has to be made.

The lamps in the auditorium are lowered when required by the introduction of resistance into their circuit in the ordinary manner, since there are other lamps on the same machine, and the introduction of a resistance into the shunt circuit would of course affect the whole of the lamps. Other groups of lamps which have to be raised or lowered separately are regulated in a similar manner.

The raising and lowering of the lamps is effected by means of four eight-way switches, so that the change can be made in as many stages.

The wiring is still as in the original installation, and it has been carried out in such a manner as completely to guard against all risk from fire. The main leads are nowhere allowed to cross, but are kept throughout at a considerable distance apart. When the installation was first carried out no safety fuses were used, as they had not then been invented; but these have since been inserted wherever a branch wire leaves the mains. They are of the ordinary pattern used by Messrs. Siemens, on earthenware bases, and no combustible material is used in their construction. No double-pole fuses are used, as Messrs. Siemens object to bringing the leads close together, which their employment necessitates; but in the engine room a fuse is placed on each of the main leads.

As is usual, there are pilot lamps in the engine room, carried on each of the circuits, which, in addition to assisting to light the room, keep the engineer informed as to whether the lights in the theatre are turned up or down, and whether everything is going on all right. No gas is used on the stage during performances, so that the principal element of danger in gas-lighted theatres is avoided, and though it is kept burning in the corridors, and a single jet is kept lighted in the dome of the auditorium, in case of a breakdown in the electric light, it is not at all likely to give rise to any danger of fire in these positions.

AN EXPERIMENTAL METHOD OF FINDING THE WORK EXPENDED IN ESTABLISHING A MAGNETIC FIELD.

The *Comptes Rendus* contains a note by M. A. Witz, in which is described an experimental method of determining the energy expended in establishing a magnetic field. It is known that if W be the work so expended, L the coefficient of self-induction of the circuit, and i the current at any time, we have for W the value

$$\int_0^t i \frac{d\,L\,i}{d\,t};$$

W can therefore be calculated if we know L; but this is not usually the case.

M. Witz's method of experiment is very simple. The solenoid containing a soft iron core is placed in parallel with a coil of the same resistance, but without self-induction. An ammeter is connected up with the latter, and a sensitive differential galvanometer is placed in circuit with the two branches. Upon closing the battery key we then get a throw of the galvanometer needle, although there is no steady deflection when the permanent state is reached. The solenoid is now removed and an equal resistance without self-induction is substituted. [This portion of the experiment is not fully described by the author, but we take it that the above is the method followed.] The resistance of this branch is now increased by an additional resistance r, and r is adjusted until on closing the circuit a throw of the same value as before is obtained. Knowing the current i in the branch, we know, therefore, the additional energy $i^2 r$ expended, and this is manifestly equal to the energy previously expended in magnetisation.

In order to determine whether the energy restored on demagnetisation was the same as that expended in magnetisation, M. Witz balances a solenoid as before against a non-inductive resistance with a differential galvanometer, and then allows a soft iron core to fall freely through the solenoid.

In describing the experiment M. Witz says that it can be assumed that the core comes from an infinite distance and is removed to an infinite distance, and under these conditions if the energy given up on demagnetisation is the same as that expended in the first instance there will be no deflection on the galvanometer. But such a deflection is always found, and, as might have been anticipated, it is greater with a solid than with a laminated core. But in addition to the loss in Foucault currents it is clear that unless the velocity of the core is uniform during the passage through the solenoid further errors will be introduced. The method does not, therefore, seem particularly well adapted to determine the question in view.

REVIEWS.

Voltaic Electricity. By Thomas P. Treglohan. (London: Longmans, Green and Co., 1888.)

In the year 1874 it appears that the South Kensington examiners in science required the students in the elementary stage of electricity to answer the question, "What is your notion of the voltaic current?" We will not stay to consider whether this was a fair question to ask an elementary student; but we may be sure that the replies received would be "considerably various." Whether any greater unanimity might be anticipated from students who have now the advantage of studying Mr. Treglohan's little book is doubtful, seeing that he is wise enough to abstain altogether from giving any "notion" upon the subject, either his own or other people's. Notwithstanding this omission, the book is well adapted to serve the purpose of those whose ambition is to acquire enough information to gain a South Kensington certificate. We note, by-the-bye, that the South Kensington teachers have not as yet abandoned the use of such terms as "tension" and "quantity."

Laxton's Price Book, 1888. (London: Kelly and Co.)

The present issue of "Laxton's Price Book" makes the seventy-first edition of this well-known annual, and contains above 72,000 prices. It is unnecessary to comment upon its value to architects, builders, engineers, and contractors, by whom it is accepted as fulfilling an essential requirement of their business. As regards the electrical industries the information furnished is confined to the retail prices of fittings or appliances for domestic use. Hence we have electric bells and fittings, including burglar alarms (fire alarms are omitted), telephones, and electric lighting. The information under each of these heads is accurate so far as it goes, but might, we think, be extended with advantage in some cases. In telephones, for instance, the class of apparatus specially designed for domestic or office use is conspicuous by its absence. The section on electric lighting must have been a difficult one to compile in a satisfactory form. It has, however, been well done, and will afford much useful information to would-be purchasers.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

ALTERNATE-CURRENT TRANSFORMERS.

The adjourned discussion on the papers by Mr. Kapp, Mr. Mackenzie, and Prof. Forbes was continued on Thursday, Feb. 23, Mr. Graves, the president, in the chair.

The President announced that some diagrams had been placed on the wall illustrating Prof. Ayrton's experiments described at the previous meeting, and

Mr. Lamb, one of the students of the Central Institution described the diagrams (Figs. 1 and 2) illustrating the experiments carried out by Prof. Ayrton (and described by him at the previous meeting) to determine the efficiency of the Kapp and Snell transformer. Fig. 1 represents the transformer enclosed in the calorimeter, by which the true watts were determined. There were also in circuit the wattmeter W, the dynamometer D, and the voltmeter V. The ratio between the reading of the wattmeter and the true watts was given last week by Prof. Ayrton (see *Electrician*, February 24th, p. 421*). The curve in Fig. 2 shows the true efficiency as calculated from the calorimeter observations, and also the values obtained from the wattmeter, and from the product of the readings of the dynamometer and the voltmeter.

* *See* also the report of the meeting of the Physical Society in the present issue.

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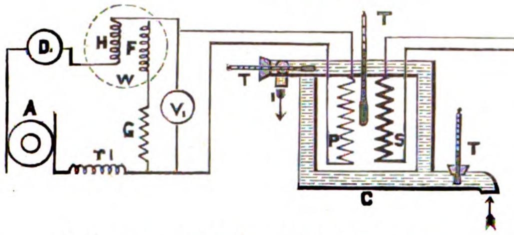
Mr. J. E. H. Gordon, while fully appreciating the scientific interest of these appliances, and the great practical use that had been made of them, could not help feeling that it was a pity to see so much ingenuity, so much skill, and so much labour lavished on what, in his opinion—possibly he might be wrong—could only be intended for a makeshift to enable them to go on until something better was ready. If he might be pardoned for putting into a scientific discussion a word of autobiography he might say he was not altogether incompetent to speak on the development of alternate-current machines, for he supposed few people had been so deeply committed to them as he had been, or had to do with the actual practice of such large ones; and yet, even at the expense of abandoning every patent that he held, he had been so far convinced of the superiority of the method of distribution by storage batteries that he preferred to abandon his own system. They had all heard with a thrill of interest and delight of the 42ft. machines. It was not quite a new thing to think of these machines, although it was a new thing to give an order for them. He had made sketches of one—in fact, had gone as far as the working drawings—about a year and a half ago, and he admitted he was much tempted to go on. It would be very delightful to have such a machine. It would be worth running a great deal of risk merely to see such a mass of machinery moving and going round above your head; but to quote a French expression, "*C'est magnifique, mais ce n'est pas la guerre*," which may perhaps be translated by saying that that delight would be more felt by the engineer than the shareholders.

Fig. 1.



A, Dynamo; C, Calorimeter; T T, Thermometers.
P and S, Primary and secondary coils.
D_1 and V_1, Dynamometer and voltmeter in primary circuit.
D_2 and V_2, Dynamometer and voltmeter in secondary circuit.
W, Wattmeter; H being thick wire coil, F suspended fine wire coil of 2·16 ohms, and G the stationery non-inductive resistance of 895·5 ohms in series with F.
r_1, Adjustable resistance in primary circuit.
r_2, Non-inductive resistance in secondary circuit.

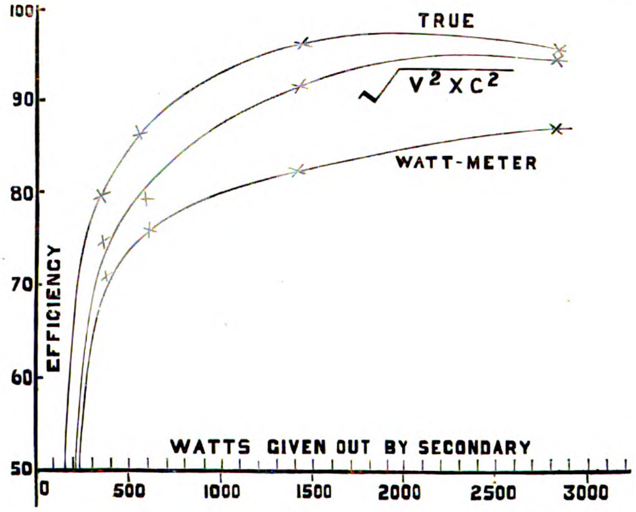


Fig. 2.

He was not speaking of the abandonment of alternate-current machines, nor was he speaking of them as if they had been failures, or as if they did not work economically. His alternate-current installation at Paddington had worked for two years, and was now working, and in one year they had supplied 800,000 units of electricity. It was supplied at a price that was extremely low, and which they should not shrink from. It was only from reasons which he would give in a moment—which he hoped would be convincing—that he thought storage batteries were better, not because alternate-current machines were bad, but because he thought there was something else better, and therefore he had determined to abandon them. The first consideration was the space occupied by these machines. They knew that experiments had been made for employing a number of small alternate-current machines, and that these experiments had been successful at the South Foreland; but that was because they were working with arc lamps. Many people had tried to work alternate machines in parallel, but they did not work together till they had jumped for three or four minutes. Now three or four minutes' jumping in the big machines might take a month's life out of 20,000 lamps, and that loss was rather a serious difficulty. Therefore they might take it in practice—he was not talking of what might be done in the laboratory—that they would not couple alternating machines, and that they must have very big machines if they were to get alternate currents to do the work. Those machines took up a dreadful amount of space. He did not think 10ft. diameter was an out-of-the-way size for a machine to give 200 to 250 units per hour, and that was what their Paddington machines were doing. Mr. Crompton was now making him machines with armatures 16in. in diameter, and two of these will do the same work as one of the 10-foot machines. If they had alternate-current machines they must practically be placed outside the town, and the wires and mains must be brought into the town. But with these modern direct-current machines, and with modern engines such as Mr. Willans was making for them, they could pack the machinery so close that they could get an immense power in a small place, and none of their neighbours were any the wiser. His company, the Whitehall Electric Supply Company, were, at this moment, putting in plant within a quarter of a mile of this place for 10,000 lights, and had room in the engine house to extend the supply to 20,000 lights. They were using an engine house 86ft. by 40ft. That included boilers, batteries, and everything else. It might be said that 20,000 lights were a drop in the cup in London lighting, and they had to face the question as to whether they were going to put up very large stations or make numerous stations of about 20,000 lights. They all knew that one of the advantages of central station lighting was the great economy in management and working that was obtained by increasing the number of lights from one station. But that increase did not go on indefinitely. Now, if they had got about 500 lights, they would find, roughly speaking, that the cost for wages in the 500-light plant would be about 10s. per lamp per year. When they went up to 10,000 lights, they would reduce that to perhaps 1s. 2d. per lamp per year. But after 20,000 lamps they did not get any further decrease in the wages, because they must have more machinery—they must have more room and more men, and it increased *pro rata*. Therefore there was no doubt an advantage in having more than one station to work more than 20,000 lamps. They had the further advantage that if there were a number of stations of from 10,000 to 20,000 lamps, and they were working with direct current, they could couple those stations together. One

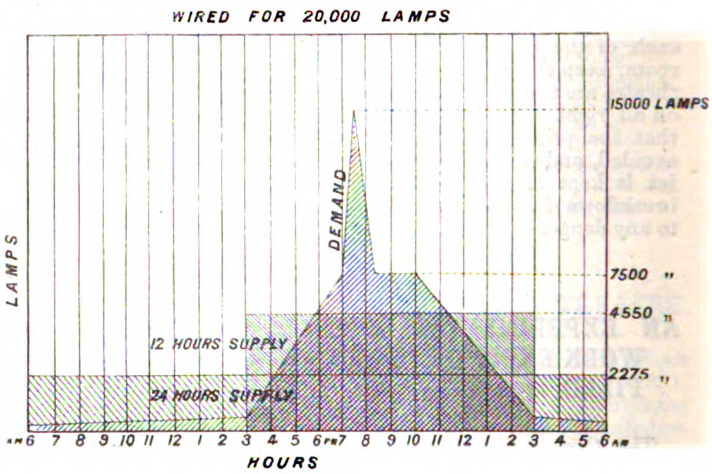


Fig. 3.

might be working at one end of a main, and one at another; and if anything went wrong at one station the other station could help it out. There were certain definite reasons which he thought would always make a number of small direct-current machines more economical in working than any big machines, and he would go somewhat briefly into it. The first was a reason which he could explain better by a diagram, which he had had placed on the wall (Fig. 3), showing the curve of output of current for a residential district and taken from actual figures. That diagram showed that the maximum demand was very much greater than the average. Hotel districts and club districts showed different curves. The diagram represented hours from six one morning to six the next morning. The vertical ordinates showed the number of lamps, and assuming that the installation was wired for 20,000, the number of lamps was small till about three o'clock, say, on a winter afternoon. Then it rose pretty steadily and regularly till about six o'clock. Then it went up in a rush. Then it came down and remained pretty nearly constant from about half-past eight till about ten. That was the time when the first batch of people went to bed. Then it sank gradually. There was apparently a great line of virtue about ten o'clock. People who stayed up after ten o'clock seemed to be reckless of hours of morality, and merely dropped off one by one until the morning. The reason of the rise between seven and half-past was rather curious. That was the time when people went up stairs to dress for dinner. About the same time the servants are laying the cloth in the dining room. So it happened that that was the only time that the lights in the dining room and the bed rooms were lit at the same time. That sent the current up with a rush. Assuming that they were working with an alternate-current machine, with 20,000 lights wired, and they had, say, 15,000 lamps in use, in order that there should not be a breakdown they must have their machine powerful enough for 15,000, and that meant not only that the alternate-current machine, but that the engine, boilors, dynamo, and engine house must all be up to that size. Assume also that they were supplying by a contract based on meter. It would then be evident that a great portion of the machine was only earning money for an hour and a-half in the 24 hours,

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and that half the power of the machine was wasted for at least 12 hours out of the 24. But the interest on the cost of the machine was going on for the whole 24. Now let them see what would happen if they had storage batteries. Assume first of all that they were going to have a moderate amount of storage, and would work their machines for 12 hours. The quantity of electricity for the day was shown by the area of the demand curve; that showed the number of units—and the area of this second curve, or 12 hours' supply, must be the same as the area of this other curve, showing the quantity required for the day. If they had storage and worked their engines for 12 hours, the maximum current need only be a current for 4,550 lamps. The size of the engines, burners, and boilers was fixed by that. Therefore, for 20,000 lamps, with an occasional supply of 15,000 at once, it was not necessary to have, by storage, machinery of greater capacity than 4,550. If, however, they decided to work their engines for 24 hours—which might in some circumstances be advisable—they could then have something much smaller still. He supposed in practice, what they would do in designing a new installation would be to so arrange that the engines, when they are first put down, are to work twelve hours to meet the demand, and then as custom comes in they could decide according to circumstances whether they would increase their engine power, or whether they would increase their battery power and work longer hours. But probably they would commence working twelve hours and increase the hours of working as custom came in. He must further point out that whatever percentage loss there might be in the storage batteries must be calculated not on the whole area of the curve, but only on those portions of the supply and demand curve which do not overlap - a very different thing. That dealt with the capital cost of the plant. The next point was the efficiency of the dynamo. Mr. Mackenzie knew perhaps even better than he himself did that the efficiency of the alternate-current dynamo was quite different when it was fully loaded from what it was when not loaded, and the alternate-current dynamo that would give, say, 4,000 horse-power a day, and give a very good efficiency, say 90 per cent., or whatever it might be, would not have anything like that efficiency when the dynamo was working at a half or a third or a quarter of its power. There was, however, a much more important point than that. The alternate current machines, whether used direct, as was their practice in Paddington, or when used in these transformers, required for their successful adoption that the number of alternations per second should be sensibly constant—that is, they must not greatly vary the speed of the engines and the speed of the dynamos. They must run their engines at very nearly the same speed whether they were giving their full power or whether they were giving only a fraction of their power. He would ask them what the diagram of a quadruple expansion engine of 5,000 horse-power would be, working at full speed at 1,500 horse-power? Probably two cylinders would be working one way, and pulling the other two round, and the diagram would be of a somewhat peculiar nature. Experience showed that a compound engine, working at full speed at a third of its power, burnt at least twice as much coal per horse-power as when it was working at its full power. Now, these smaller engines that were used for storage current might be easily coupled together. They worked their engines at their full power until they had obtained the storage they wanted, and then they stopped. The engines were either worked at their full power or were stopped. Therefore they were bound to get a far better economy than could be obtained by working big compound engines at half their power. There was another reason for scattering stations, and placing them where you could use engines that would not be a nuisance in great populous districts. London was now being filled with great buildings, residential flats, great hotels, and buildings of that sort, and the best site of a station was somewhere near one of these, where they could use their lamps to begin with, as there they could for the first time meet the gas companies on their own ground, and utilise *waste products*. At Whitehall he had taken a contract to sell a quantity of hot water day by day that would use up the whole of his waste steam, and thus what was formerly an expensive nuisance was converted into an important source of revenue. He did not, however, wish to be too precipitate in his condemnation of the transformer. These were two systems, both endeavouring to do their work as best they knew. He felt that his friend Mr. Mackenzie was doing good work in educating the public to the use of electric light, and persuading them to wire their houses. Mr. Mackenzie's customers would, he hoped, then transfer their custom to him on seeing the advantages of the storage system. Perhaps they must not allude to it too particularly, but they might remember that there was yet a third system of electrical distribution which they had heard of a great deal within the last few weeks, which he thought none of them would wish to assist more than they could, and that was the system of distributing electricity from house to house by means of circulars.

Mr. Crompton said they were discussing two papers on transformers, and he thought his friend Mr. Gordon had rather wandered away from the subject. He hoped they would check him if he wandered away in the same direction, because there was a great tendency to do so. The subject of transformers, taken by itself, viewed more particularly from the side Mr. Kapp had viewed it, was of a somewhat dry nature, and they would, he hoped, excuse him if he tried to infuse a little more liveliness into the discussion. The lighting of the future, so far as they knew at this present moment, was going to be handed over to the one system or the other, to battery transformers or to alternate-current transformers. He considered that the questions that these papers had raised at the present moment were of supreme importance. The company that he had been more particularly speaking of—for which they had the highest respect—the Grosvenor Gallery people, had done a very great work, and he thanked them most heartily for educating the people of London to like the electric light. They were showing how people would put up with any sort of light. It was very difficult to follow a very good man over his ground, but it was very much easier to beat a man who was not quite so good, and in that case he thought the Grosvenor Gallery gentlemen would excuse him if he said that they had a little to learn still in the way of producing the electric light. Hitherto they had produced scintillations which were not altogether pleasant to people who were sitting at five o'clock tea in a Mayfair drawing room. He believed that Mr. Mackenzie had explained many of the causes of these things, which of course they must not laugh at; but as an opponent he took advantage of them, because he believed they were inherent in the system. He believed that with the alternating transformer system, as at present arranged, they were very greatly dependent on what their neighbour did, and that accidents to their neighbour's transformer affected an innocent person several blocks off in a way that could not happen with the direct system by distribution carried on from a series of accumulating or storage centres. He had long had the two systems before him, and he had been working at the subject for the last two or three years. As most of them knew, he had carried out central stations in which the transformation from high-tension currents of 500 volts had been carried down to 100 volts, usually employed in incandescent lamps by means of four batteries in series. He had data from these installations, and data which were of use. It was no use in such a place as that to discuss the question of management—that is to say, wages and matters of that kind—but it was of great use to discuss the scientific engineering part of it, that is, the question of which system worked with the least horse-power, which worked with the least first cost in machinery, the least first cost in mains, and the greatest steadiness and regularity and freedom from breaks down. From these points of view he proposed to compare the system of alternating transformers with the system of battery transformers. At this stage he would remind them of the tremendous leg-up which the alternating transformer system had received from Mr. Westinghouse. Westinghouse was one of the most wonderful men in the world. There was no man like him as an organiser of labour and as an organiser of machinery. Witness his brake. In the face of the most tremendous opposition from the railway authorities he had made his brake almost universal, and he had done that with all these peculiar powers. He was a very rich man, and he had unexampled facilities at the town of Pittsburg, where his most successful lighting had been carried out. But he would tell them that what Westinghouse had done for the transformer system was exactly what Brush did for arc lighting when they used arc lighting—they might say for the first time—in England a few years ago. He had turned out from a well-appointed factory complete, well-considered sets of machinery, packed and sent away to any township in America that wanted electric light of a sort. It could be put up in the way that American electric lighting machinery was done—very roughly—on the spot. But the things were so well appointed and so well made in the factory, that they could be erected at small cost, and in sufficiently good rough and ready fashion to suit the American taste. Anybody who had been in America, anybody who knew anything about American installations would confirm what he was saying—that electric lighting machinery in America as made in the shops was perfection; but the putting of it up was such as would not pass muster in the worst of our English installations. That had been the case with the enormous list of transformer machinery that had been carried out by Mr. Westinghouse. Although that was perfectly suited for such countries as America and Australia, countries where rough workmanship and such things did, it was quite unsuited for civilised countries. The alternate-current transformer was well suited for such cases, but the moment they brought it into London, the moment that it was no longer a rover, as it was at present, over the tops of the houses, the moment they confined it under the streets, then it lost all its advantages. What were its advantages? Its advantages were that they could put down a station, and they could run wires anywhere they pleased, on account of the peculiar state of the law, and take up a number of customers that otherwise they could not reach at all. But he said that when the taste for electric lighting became more universal, when two in every three people along the line of streets took the light—that such a system of overhead mains and that kind of thing was intolerable; and there must come the day when mains had to be laid, as they had been successfully laid under the streets, and then they would find that the alternate transformer system was out of it as compared with the other. He was glad to see that Mr. Kapp, in his paper, practically admitted that. He admitted it in his last sentence, and a man puts his sense in the last sentence of his paper. The fact of the matter was, when Mr. Kapp said they would have to lay down a network, and when Mr. Mackenzie said they would have to lay down a network, he would like to know in what way they would lay down a network cheaper than the batteries. The mains could be laid in the streets from 14s. at the lowest to 16s. or 18s. a yard at the highest. The smallest section of copper could not be put in under 14s., and 16s. or 18s. would give them a very fair section of copper quite sufficient for an ordinary length of streets. When people talked of copper as if copper were the only thing that had to do with the cost of conduction, they were talking nonsense.

This was not the place to go into a long comparative estimate as to the cost of the two systems; suffice it to say, he had figures in his possession that he had worked out very carefully. He would not take the extreme figures mentioned by Mr. Mackenzie, who assumed 100 volts and transmitted it through an inch and a-half cable with 1,500 amperes at 100 volts potential. By taking 500 volts, which was workable for a distance where the generating station was situate from a mile to two miles from the centre of the district to be supplied, the cost of the two systems works out practically identical. That was to say, if 10,000 lights had to be supplied in a town, with the generating station situate not more than two miles from the centre of the supply, the cost of those 10,000 lights—and he called the maximum number at one time 10,000 lights—the cost was identical in the two cases, and there was no saving by using the alternate system.

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Now, he would attack the alternating system as an efficient one. They had heard a lot about the efficiency of transformers. There had been a fight over a few places of decimals. That was whether they were 80 or 90 per cent. They had got efficiencies showing that at a very low heat indeed the true efficiency was as high as 80 per cent. of the transformer, and he did not believe that. The large transformers that would have to be large enough to go up to the peak of the diagram shown by Mr. Gordon, but when they were working in the day time, they would not be working at much more than 15 to 20 per cent. efficiency. Further than that, those transformers were worked by very large dynamos. Mr. Mackenzie talked about 42ft. 5,000 horse-power dynamos, and they were told that the total size of the station was 20,000 horse-power. He would like to know how many tons of coal per lamp (laughter) it would take to work those lamps at the day-time. He had made some experiments in this direction, and he knew from experience in years gone by, and from later experience, what it meant to run engines, even with continuous currents, without the aid of batteries, *i e.*, to run them nearly empty. There was not a more extravagant beast on the face of the earth than a compound or triple expansion engine worked down to a fourth or a fifth of its full output. As Mr. Gordon said, the two other cylinders were nothing more nor less than air pumps—drags on the engine, and Mr. Willans could tell them a great deal better than he could what they would do. They might put it in this way: These big engines used about two-thirds of the coal when empty that they did when full—that is to say, if using 20 tons a day when full, when they were running one lamp they would be using about thirteen or fourteen. So they could seen what it came to. Everybody who worked central stations knew these facts Mr. Mackenzie knew them He knew how much coal they were burning now at the Grosvenor Gallery, and he (Mr. Crompton) knew, and he could tell them they were burning five times as much coal at the Grosvenor Gallery, lamp for lamp, as he burnt at Vienna. That was because *he* employed accumulators, and *they* were wasting their coal by having to keep a big engine running for long hours when there were very few lamps on. If Sir Coutts Lindsay had asked him to put up a battery system about two years ago, Sir Coutts would have saved enough money in his coal bill from the time he started to pay for two new batteries. Mr. Gordon's diagram was almost an exact copy of half-a-dozen diagrams that had been shown to himself this evening by Dr. Fleming, which had come from the Edison Company in America, and referred to various installations. That diagram of Mr. Gordon's, which he knew was founded on London experience, was almost a correlation of work that he had done at Vienna, and it was exactly corroborated by those most interesting diagrams that Dr. Fleming had got, which pointed out that there were peaks for only an hour or a couple of hours' duration, when the demand was nearly double that of the other maximum demand—he meant by the latter the demand that lasted for three or four hours—and something like 10 or 12 times the average demand. He thought the whole pith of the economical question lay in studying diagrams of this kind. The whole thing was turning on the one question that was raised by Mr. Mackenzie. Mr. Mackenzie had thrown doubt on the question which had been over and over again asserted, that they could not run alternate-current machines in parallel. If they *could* run them parallel, that would knock the bottom out of a great many of his (Mr. Crompton's) arguments. There was no doubt about that. But it had not yet been done—he had taken very great pains to find out whether it had been done in practice—but it certainly had not been done here in England, and it had not been done in America otherwise than experimentally. When these gentlemen could use them so that they could follow the lines he did of putting one dynamo on after another, and working them up to their full capacity and their best efficiency as the demand arose, and fill up the sharp angles between the dynamos by working accumulators in parallel to them—till these gentlemen could do that they would never approach the efficiency that he had at present. He believed from Mr. Mackenzie's statements and from all the rest he could hear, that Signor Ferranti had virtually admitted that they could not put the machines parallel by his desire to construct these gigantic machines that were mentioned in the paper.

Mr. Esson said that coming after a most energetic representative of the anti-transformer party he wished to express his indebtedness to Mr. Kapp for his most interesting and instructive paper. In dealing with this problem Mr. Kapp had introduced the graphic method, which was always a great boon to the engineer, inasmuch as he could see at a glance what had taken place, and was able also to apprehend better the modifications in results obtained by the modifications in proportioning. Throughout his investigations, however, Mr. Kapp assumed that the electromotive force impressed in the primary, or rather the electromotive force generated by the dynamo was a sine function of the time. But surely in modern machines, with iron cores in their armatures, that was not quite the case. He could believe that in a Siemens dynamo the curve would be a sine function, and also in a Ferranti dynamo the deviation might not be great, but in a dynamo having an iron core in its armature, he could say most decidedly it would not be a sine function, nor would it be anything approximating to a sine function. He had endeavoured to map out the magnetic field in a dynamo something like Mr. Kapp's own design, where they had a disc armature with sets of poles on each side. The result, so far as he could make out, was shown by the diagram skied to the right, where A (Fig. 4) is the curve of sines, and B is the curve got from the dynamo. They would see the flat part in the middle. That part might be a little too long in the diagram, but its length depended entirely on the construction and the proportions. He did not say that the deviations detracted from Mr. Kapp's method, but they certainly modified the results he had obtained both in the mathematical and the geometrical treatment. One must, of course, assume something as a basis in the absence of experimental data. Mr. Kapp assumed the curve of sines, and the question arose, how much the results were modified by deviation from that curve? His own view was that no true result could be obtained without actual experiment.

The point regarding the degree to which the core of the transformers could be saturated was most interesting. From Mr. Kapp's investigations it seemed that the number of C. G. S. lines was only one-half of what could be employed in the armature of a continuous current dynamo. He would like Mr. Kapp to state what was the usual weight of transformer per 60-watt lamp, and also how many volts he got per foot of conductor. In the Westinghouse transformer, he believed, they got 2 volts per foot. There seemed to be very little difference in the construction of the transformers, excepting that the object in some cases appeared to be variation rather than an improvement. He thought the transformer of Mr. Kapp had an advantage over others, inasmuch as it could be taken to pieces. They had simply to take the cover off it, take the coils off, and slip a fresh pair on. Taking the whole arrangement to pieces, as they had to do when they had the iron parts interlacing with the copper parts, might be sometimes rather inconvenient.

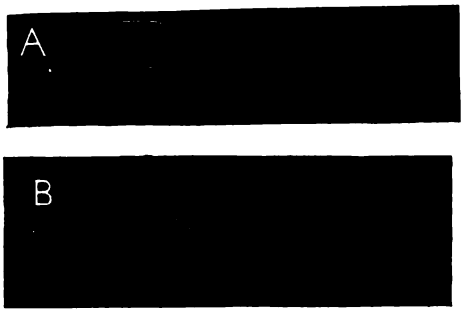

Fig. 4.

Leaving transformers and coming to the distribution, it seemed that here there was some little room for discussion. He understood Mr. Bernstein to advocate the series system, and in his paper Mr. Mackenzie showed himself rather favourably disposed towards it. It appeared that putting a constant current in the primary they had a current which was practically constant in the secondary, and therefore the arrangement was admirably adapted for lighting lamps in series. So far, then, as self-regulation went, there was no difference between the two systems; but when they came to the question of cost he thought that the conductors would cost more, in any case, in the series system than it would in the parallel system. They had to keep the same section of conductor right through the system. If they had to go down 100 yards to light a single lamp they would still carry a heavy conductor with them wherever they went; and although Mr. Kapp said that in sparsely populated districts the cost would be less, he himself could not quite make out how it was. As regarded the dynamo of Mr. Kingdon, he did not think very much of it, and for the reason already referred to by Mr. Atkinson. The magnetic circuit should not be subject to constant changes in section as the machine is working, otherwise Foucault currents would be induced in the magnet. He prophesied that the machine would get hot. He would be very glad to learn that it was not so; but if it was not so it could only be by laminating the field, which he was afraid would be rather expensive. In conclusion, he had been very much puzzled by the last sentence in Mr. Kapp's paper. He was not quite sure whether it was intended to be prophetic or not. If Mr. Kapp thought that they really would get batteries sufficiently improved to render lighting by continuous currents possible in the future, it would be a great pity, though having the conductors all right, to find at the generating station that he had his dynamos of the wrong kind, and that the transformers were also useless. He therefore advised Mr. Kapp to give up the alternate-current system, to put in at the generating station high-tension dynamos, and to use continuous current transformers at the sub-stations. He would then be ready, on the contingency of a good battery arising, to supply by storage. He could either charge his accumulators direct from the central station, he could charge them through his transformers, or work the lamps from the transformers. He (the speaker) did not say that the system of working with a continuous current transformer would be quite of such high efficiency as the alternating transformer system. Neither would it be so low as working from accumulators, as Mr. Crompton advised, but it would be somewhere between the two, and the accumulators would be simply used as a stand-by. They would be charged occasionally, just to make up the leakage.

Mr. Sidney Evershed said that Mr. Esson had anticipated a few of his remarks in his protest against the importance of the sine function. There was one very good reason for employing it, however, and that was that it was the only one which could be worked mathematically. It was rather remarkable that the sine function was, so far as he could see, the only one which was reversible—that was to say, that the secondary current would also be a sine function of the time. According to Mr. Crompton's view, the sense of the paper was in the end, and, therefore, perhaps the sentence was really nonsense where Mr. Kapp said he had reason to think that a curve of electromotive force, of whatever shape, produced by the machine would, after filtering through two or three transformers, come out as a true sine curve. Of course, Mr. Kapp, with his beautiful geometrical method, hoped that it would come out as a true sine curve; but he was himself afraid that the facts were against Mr. Kapp. He thought the effect of filtering it through one transformer—and one would be all-sufficient—if the original curve departed in any way from the sine curve, the effect

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would be to make it depart still more from the sine curve. However, that as Mr. Esson said, did not detract from the merits of Mr. Kapp's paper in the least, nor from his method; but it did in some measure detract from the interest of the results obtained, because if the sine function was not a true one, what became of all the results Mr. Kapp arrived at—such as the power spent in a transformer being equal to the virtual E.M.F. into the virtual current, into the cosine of the angle of lag? Mr. Esson had been good enough to give the meeting a diagram of one curve, which showed what a complicated function a modern dynamo might give. The Westinghouse dynamo was also supposed to give—not a sine curve, but something like a zigzag of straight lines. The only way he could see of attacking that problem was to assume that it was a hyperbolic function; but he could only echo Mr. Kapp's wish that some one with the necessary mathematical attainments would investigate the subject.

He should like to say a word or two about the wattmeter for measuring power. Dr. Fleming described a large wattmeter which apparently gave very inaccurate results. There was really no need for a wattmeter to be large. If Dr. Fleming were to make a wattmeter like those beautiful instruments which he showed at the meeting last year, and employ a few ampere turns—say, two or three on the pressure coil, and a large number, 100 or so, on the current coil—they would have an instrument in which there was practically no lag in the pressure coil, and consequently it would give the mean of the true instantaneous watts. He had made a wattmeter which worked very well indeed with about 100 ampere-turns in the current coil and about five ampere turns in the pressure coil; and he imagined Mr. Kapp would not object to five ampere turns, when they remembered that in an ordinary incandescent lamp there might be perhaps one ampere-turn, and it was customary to neglect the self-induction of one lamp.

Prof. PERRY said he should like to say a word or two upon this matter of the sine curve. It had been said by Mr. Esson and by Mr. Evershed that the curve was not a true sine curve, and therefore that Mr. Kapp's theory must be wrong. Before, in that room, he had made a correction of such statements. He understood that Mr. Esson measured his field—the field of the dynamo machine—to get this particular curve. If they got Mr. Esson's curve for the field, then the current—the primary current—would obey very nearly the sine law, and the law of the secondary from the transformer got nearer to a sine function still. The effect of self-induction and mutual induction was that they took out the minor ripples. A curve like that of Mr. Esson's was built up in this way, of several sine curves of different periods [illustrating on the blackboard]. A combination of one sine curve and its harmonics would give the curious curve that Mr. Esson described. They found that if they had one sine function of a certain period, another of twice that period, and others three times that period, they could get exactly what the effect of self-induction was in toning down the ripples or the harmonics. They found that they were toned down tremendously. It depended on the self-induction. All those ripples were toned down, and the quicker ripples toned down very much more rapidly than the slower ripples in passing through the transformer, and he did not think it was possible by any method of measurement to get anything very different from a true sine curve in the secondary current. The time was very late, but it would not take him more than two minutes to mention to the meeting something that suggested itself to Prof. Ayrton and himself some time ago with regard to an instrument for measuring the actual way in which the current does change. Mr. Esson, Mr. Evershed, and others had said that there was not a true sine curve. Well, then, there was a way of testing it, and the way of testing it would be this:—Not only was this a beautiful investigation in itself, but any person carrying it out must become familiar with Fourier's method of analysis and impressed with its beauty. It was like Helmholtz's method of analysing a sound by resonators. Let them take a dynamometer, and send the alternating current through the thick wire coil only. Then let them take the fine wire coil, and have a little battery with a make and break, and let that make and break be controlled in some way so that they could readily vary the rate of vibration—the rate of vibration, say, of some tuning fork. Let it be varied, so that they could measure the rate of the make and break. The main current might have any amount of ripples in it that they liked to assume. Now when the rate of alternation in the fine wire coil reached the fundamental rate of alternation in the current coil, and then only, they would have attraction between one coil and the other. If the main current had no other rate of alternation than that, according to Fourier's theorem they would have no action of the one coil on the other, except at that one rate of vibration. So that by changing gradually their make and break—changing it to quick from slow—they looked out for an indication. And when their readings on this instrument were greatest, when they knew they had got the alternation of the main wave—the main alternation of the current—they had got their main wave then, but they had not got any of the ripples. They now continued to quicken their make and break, made it quicker and quicker, and when they got to twice the rate of vibration they would probably see some indication. If it was small it meant a small ripple of twice the ordinary alternation rate. Well, let them measure what it was, then go quicker and quicker till they got about three times the first speed. They would probably get another indication. Probably there was some period which had a pretty big effect. If he was right, however, in what he had been saying about the toning down of the ripples, they would not get much indication at any other speed than the one speed which indicated the main wave. It was easy to take the results and combine the measured fundamental wave with its measured harmonics, to find the real shape of the current function. It would be known to members that if the coils were at right angles to one another mutual induction would vanish and no error could arise from this cause.

(To be continued.)

BOOKS, &c., RECEIVED.

"Laxton's Price Book, for Architects, Builders, Engineers, and Contractors." 1888. Originally compiled by WILLIAM LAXTON. Seventy-first Edition. (London: Kelly and Co., 51, Great Queen-street.)

"On Electric Lighting in Works and Factories." By Prof. J. A. FLEMING, M.A., D.Sc. Reprinted from the *Journal of the Iron and Steel Institute*, by authority of the Council. (Edinburgh and London: Ballantyne, Hanson and Co.)

"Electrical Tramways: the Bessbrook and Newry Tramway." By EDWARD HOPKINSON, M.A., D.Sc., with an Abstract of the Discussion upon the Paper. Edited by JAMES FORREST, secretary.

"Excerpt Minutes of *Proceedings* of the Institution of Civil Engineers." Published by the Institution.

"Pott's Mining Register and Directory for the Coal and Ironstone Trade of Great Britain and Ireland." 1888. (London: Simpkin, Marshall and Co.)

"The National Telephone Company's List of Subscribers for the Yorkshire District."

"Money and Money Problems." By J. SHIELD NICHOLSON, M.A., D.Sc. (William Blackwood and Son: Edinburgh and London.)

MEETINGS OF SCIENTIFIC SOCIETIES.

TO-NIGHT (FRIDAY), March 2nd.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Amateur Concert (Ladies' Night) in the Banquet Room of the St. James's Hall Restaurant.

ROYAL INSTITUTION.

9 p.m. Lecture on "Poisons and Poisoning." By Dr. C. MEYMOTT TIDY, M.B., F.C.S., &c.

SATURDAY, March 3rd.

ROYAL INSTITUTION.

3 p.m. Lecture, "Experimental Optics" (7). By Lord RAYLEIGH, M.A., &c.

MONDAY, March 5th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III. "The Modern Microscope" (2). By Mr. JOHN MAYALL, Jun.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at Westminster Town Hall. Paper on "The Effect of Sea Water on Portland Cement." By Mr. HENRY FAIJA, M.Inst.C.E.

INVENTORS' INSTITUTE.

8 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

TUESDAY, March 6th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be further discussed, "Manganese in its Application to Metallurgy," and "Some Novel Properties of Iron and Manganese." By Mr. R. A. HADFIELD, Assoc.M.Inst.C.E. At this meeting the monthly ballot for new members will take place.

ROYAL INSTITUTION.

3 p.m. Lecture, "Before and After Darwin" (8). By Mr. G. J. ROMANES, M.A., &c.

SOCIETY OF ARTS.

8 p.m. Foreign and Colonial Section. "South African Goldfields." By Mr. W. H. PENNING, F.G.S. Col. A. C. HAMILTON, Chairman.

ROYAL VICTORIA HALL AND TAVERN (Waterloo Bridge-road, S.E.). Lecture, "Nature's Sculpturing Tools." By Mr. R. D. ROBERTS.

WEDNESDAY, March 7th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Framework Knitting" By Mr. W. F. ROWLETT.

THURSDAY, March 8th.

SOCIETY OF TELEGRAPH-ENGINEERS.

7 p.m. Council Meeting.

8 p.m. Ordinary General Meeting. "The Present State of Fire Telegraphy." By Mr. R. VON FISCHER TREUENFELD, Member.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

3 p.m. Lecture, "Microscopical Work with Recent Lenses on the Least and Simplest Forms of Life" (1). By the Rev. W. H. DALLINGER, LL.D., F.R.S.

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THE BATTLE OF THE TRANSFORMERS.

The discussion on the papers of Messrs. KAPP, FORBES and MACKENZIE, which was brought to a close at the meeting of the Society of Telegraph-Engineers and Electricians yesterday week, has traversed so wide a field, and has been concerned with matters of such pressing importance to the electrical engineer, that it can hardly fail to exert a considerable, and, we think, a beneficial influence on the progress of central station lighting in this country. We say this advisedly, for though at the first glance it might seem that the chief result had been to show that the leading electrical engineers are at loggerheads amongst themselves as to the rival merits of battery transformers and alternate-current transformers, yet in reality the altercation arises from the fact that upon the whole the merits of the two schemes are very evenly balanced. Each of the contending parties has a sound and practical system to back up, each method has its own special advantages and its own special disadvantages, and time alone can show which of the two is fittest to survive upon the largest scale, or whether they are each doomed to fall before a system combining the merits and avoiding the demerits of all others.

Meantime it may be useful to take a hasty glance over the field of battle and to notice some, at least, of the chief points made by either of the contending parties. The partisans of the storage battery method gained an advantage at the outset by putting forward a champion in the person of Mr. J. E. H. GORDON, whose chief title to distinction as an advocate of the battery lies in the fact that he is a recent recruit from the enemy's camp. Mr. GORDON, with all the fervour of a new convert, offered a public recantation of the views which he had long been known to hold, and recited his profession of faith in the storage battery—qualifying his observations, however, by the remark that he had changed his views, not because alternate currents were bad in themselves, but because storage batteries were better. It is true that Mr. GORDON has carried out one of the very largest installations worked by alternate currents in this or any other country, but inasmuch as the use of transformers was not included in the scheme, it must be admitted that from our present standpoint his system involved all the disadvantages of alternating currents with-

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out any of the advantages of the method under discussion. Besides, no one nowadays (almost certainly not Mr. GORDON himself) would place unlaminated iron in the armature of an alternate-current machine, no one would use the method of regulation known as the "divided-main system," and, in fact, no one would dream of using alternating currents at all, except for the purpose of being able to employ transformers.

Mr. R. E. CROMPTON speaks from the vantage ground of one who has had positive experience of the system which he advocates, and his remarks deserve, as they will undoubtedly receive, the most careful consideration. The point upon which Mr. CROMPTON chiefly laid stress—and certainly not undue stress—is, that with batteries it is possible to spread the work of the engines over as a long a period within the twenty-four hours as may be found convenient; so as at all times to work the engines at full power. When, on the other hand, the supply is taken direct from the machines, the engines must at each moment develop whatever power may then be under demand. It is well known—though the fact is too frequently lost sight of—that with modern triple expansion engines, such as could most advantageously be used for large central stations, the coal burnt per indicated horse-power increases rapidly as the output is diminished. This becomes a most serious consideration when the hourly curve of output of current takes such a form as was shown in the diagram exhibited by Mr. GORDON (and which will be found in our report of the discussion in the present issue). In this case the maximum demand is ten or twelve times the mean daily average, and lasts only half an hour or so. It would, however, be very misleading to generalise from a single diagram of this description. The particular curve exhibited referred, as we understand, to a district exclusively occupied by private residents, the peak in the curve occurring at the time when people are dressing for dinner, while the servants are at the same time busy in the kitchen and the dining rooms, so that nearly all the lamps in the house are for a short time alight. But, as Mr. KAPP pointed out in his reply, it is rare that an exclusively residential district would be served from a central station, and a comparatively small number of shops, clubs, or hotels would materially alter the shape of the figure. We think, however, that the speaker is justified in preferring the use of batteries in cases where the curve of the output takes such a form as was here shown. Mr. CROMPTON was, however, careful to say that his argument was based upon the belief—after careful inquiry into the facts —that alternating machines could not be run in parallel as a matter of practical everyday working. Of course every one knows that two such machines, if driven from the same countershaft, or run at approximately the same speed, will, when joined in parallel, presently fall into step, and work in perfect harmony; yet inasmuch as the automatic process may take a minute or two to complete itself, it is not applicable to central station work. But, as Mr. MORDEY pointed out, Mr. CROMPTON is wrong in supposing that the difficulty cannot be overcome. Mr. MORDEY mentions a case where two machines are worked in parallel upon opposite sides of a river. The Westinghouse Company do the same thing in Pittsburgh; although, seeing that this company does not usually adopt this method of working, it is perhaps fair to presume that they are not entirely satisfied with the results at present obtained. We may note in passing that Mr. CROMPTON conceded too much to his opponents when he said that "the bottom would be knocked out of his argument whenever it was shown that alternate-current machines would run in parallel." The argument as to steam power holds good whether the engines are employed to drive one large or several small machines.

One piece of information we vainly waited for in Mr. CROMPTON'S speech. We were hoping to hear something about the efficiency of the battery which he is using for central station work; but on this vitally important point nothing transpired.

It was probably rather a revelation for many people to find the Brush Corporation, represented by Mr. MORDEY, declaring strongly in favour of alternating currents. Outdoing the author of the paper, he prefers, so far as possible, to abolish low-tension distributing mains altogether, and, if necessary, to place several transformers in different parts of the same building, for the reason that it is cheaper and simpler to network the high-tension than the low-tension mains. Mr. KAPP, on the other hand, would employ as few transformers as possible, and establish sub-stations from which distribution might be effected by an Edison network. The latter scheme, as the author points out, has the advantage of being readily convertible into a battery-transformer system whenever batteries have proved themselves beyond all doubt to be reliable and economical appliances for the transformation of potential.

Meanwhile, taking into consideration the difference in the first cost of batteries and alternate-current transformers, the enormous advantage of the latter in respect of depreciation, and the difference in the cost of mains represented by the ratio of 2,000 to 500 volts (in the most favourable case for the battery), it is difficult to believe that batteries can as yet compete with alternate-current transformers from an economical standpoint.

OVERHEAD CIRCUITS FOR LONG-DISTANCE TELEPHONY.*

BY M. J. BANNEUX (CHIEF ENGINEER OF THE BELGIAN TELEGRAPHS).

For long-distance telephony a metallic circuit is an absolute necessity, as with a single wire and an earth return it is impossible to avoid the noises due—first, to earth currents; second, to induction from neighbouring wires; third, to the "picking up" of the currents from other circuits in the vicinity working also with earth returns. As an example of the last the author mentions an overhead wire in Brussels which made earth some fifty yards from a Morse instrument. The two wires ran at right angles to each other, so that there could be no appreciable induction between them, yet every Morse signal could be heard on the telephone line. Again, when M. Van Rysselberghe was superintending from Ostend to Dover, the operator at the former place heard a third voice joining in the conversation, which turned out to come from the Observatory, Brussels, from which a single wire runs to Ostend. The operator at Brussels had heard and answered the voice from Dover, though the only connection between the two lines was that they were connected to the same earth plate at Ostend. Besides this picking up of stray currents, there are other difficulties. Leaving self-induction and capacity on one side, the most troublesome are leakage and induction from other wires. In wet or foggy weather if a telephone and telegraph wire have even *one* post in common, it is sufficient to make the Morse signals audible in the other wire.

The best means of stopping cross-talk, due to leakage, is, the author considers, the English method of fusing good insulators and joining all their iron supports to an earth-wire at each post; most of the leakage current then gets to earth instead of into the other wires.

Induction from wire to wire is the other *bête noire* of telephonists, and to it many operators attribute cross-talk, which is really due to leakage. It is true, however, that in our foggy climates it is very difficult to determine which is the real offender.

The effect of one wire on another is represented approximately by the formula $m = 2l\left(\log_e \frac{2l}{d} - 1\right)$, where m is the coefficient of mutual induction, l the length of the two wires running parallel, and d their distance apart.

Although telephonic and telegraphic induction are of the same nature, it will be well to treat of them separately on account of the different means which must be taken to remedy them.

* Abstract of paper read before the Belgian Society of Electricians.

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Every Morse signal, for example, gives two currents in a neighbouring telephone wire, the one reverse on making, and the other direct on breaking, and therefore two "clicks" on the telephone. Anyone who can read by sound can receive as well on that telephone line as if he had a sounder before him. If a Hughes instrument is employed the effect on the telephone is still greater, as the currents in the Hughes rise and fall more sharply, while an "automatic" is worst of all. A single Morse wire running parallel for only a short distance will make conversation difficult, so it may be easily imagined that conversation on a single wire is not only difficult but impossible when this wire runs any length along a railway, close to a number of Morse-speaking, signal-repeating, bell and other wires in continual action. The voice is completely drowned in a shrill fizzle of induced currents. The experiments made in 1883 between New York and Chicago, a distance of about 950 miles, on a single steel-copper telegraph wire, show that with a suitable conductor it

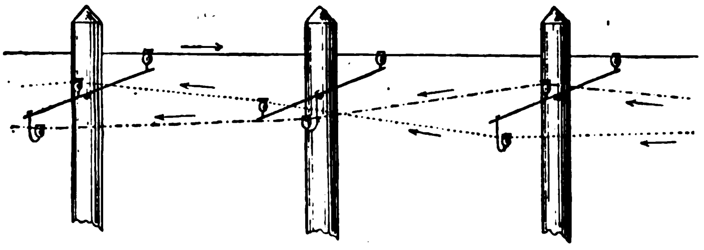

Fig. 1.

is possible to work over long distances. This, however, was only when the other wires on the line were not in use.

As to telephonic induction, if two single wire lines run parallel on the same posts for a few miles conversation on the one line is perfectly audible on the other; hence, if the exchanges of two towns are to be joined by earth return trunk wires, only one wire must be run on each line of poles. It may be asked how it is that in other countries comparatively long lines are worked with earth returns. In point of fact, it is impossible to talk to any one on these lines without taking some third party into one's confidence. When an American exchange manager was asked how they got over the cross-talk difficulty, "Oh," he said, "we just advise our subscribers to take no notice of what is going on on other wires."

We may note in passing that no advantage is to be gained by crossing earth return wires; induction always takes place, except between wires exactly at right angles.

Prof. Thompson has proposed making the transmitter ten times more powerful and the receiver proportionately weaker. This would, theoretically (leaving leakage out of account), give the voice equally loud in the receiver and diminish the effect of telegraphic induction to one-tenth. It would, however, have no effect in reducing *telephonic* induction. To the best of the author's knowledge there is only one practical system of preventing the telegraph wires having any action on neighbouring telephone wires—that of Van Rysselberghe. By this, as is well known, the makes and breaks of the telegraph signals are lengthened to such an extent that they have no appreciable effect on a telephone. This gets over the difficulty of telegraphic induction only, not telephonic. The general solution of the difficulty of induction, whatever may be the inducing causes, is to use two wires in a complete metallic

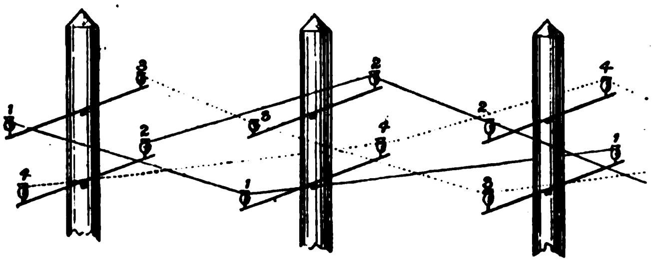

Fig. 2

loop instead of a single wire and an earth return, and to so arrange them that the sum of the inductions of neighbouring telegraph or telephone wires shall be exactly the same on both the wires of the loop. This principle was patented by Bell in 1877, and its efficacy was proved by Hughes in 1879.*

It was applied by Brooks, of Philadelphia, to cables, by twisting the two wires of the loop together.

If a line of poles only carries one telegraph wire and a looped telephone wire it is very easy to obtain equal induction on both wires of the loop; all that is necessary is to run the telegraph wire parallel to its neighbours and equidistant from both of them. The telegraph wires, however, in practice are numerous, and vary in number from section to section, and the telephone wires cannot be arranged so as to be equidistant from each particular telegraph wire. In this case it is necessary to adopt a method similar to that employed for cables, namely, to twist the wires together in long helices. Prof. Hughes suggested a plan for doing this in 1879, which was carried out by Messrs. Moseley and Sons near Manchester. Since 1881 the English Post Office have used the wiring shown in Fig. 1 for the trunk wires for joining two towns. If two trunks have to be run on the same line of poles they are arranged as in Fig. 2. Galvanised iron lines on this system are at work between Manchester and Liverpool, 30 miles; Newport and Cardiff, 13 miles; Glasgow and Greenock, 25 miles; Glasgow and Edinbro', 36 miles; London and Brighton, 54 miles, &c., &c.

In June and July, 1883, the Belgian Government established communication between Antwerp and Brussels, which towns, by the way, were the first two on the Continent which were joined by the telegraph in 1846. The trunk was run along the railways, using No. 16 S.W.G. phosphor-bronze wire, about 16lb. per mile.

The posts were not provided with cross arms, so the wires were run on the special brackets, which were fixed on the top of the posts as shown in Figs. 3 and 3A. The line was remarkably quiet; a slight fizzling was heard at times, but conversation could be carried on as easily as between two subscribers in one town. Both Blake and Van Rysselberghe transmitters were used.

Van Rysselberghe's system was applied to the Belgian telegraph lines during 1884, and the first line opened to the public in October. At the present moment (Nov. 1887) there are some 1,800 miles of double wire used simultaneously for telegraph (Morse and Hughes) and for telephone inter-urban trunk lines.

The author then proceeds to describe the Paris-Brussels line. It was agreed between the representatives of the two countries that the line should be a closed metallic circuit of No. 11 S.W.G. high conductivity wire, to be run on the telegraph posts on the railway, and to be protected from induction as far as possible, the means to be employed to do so being left to the respective Governments.

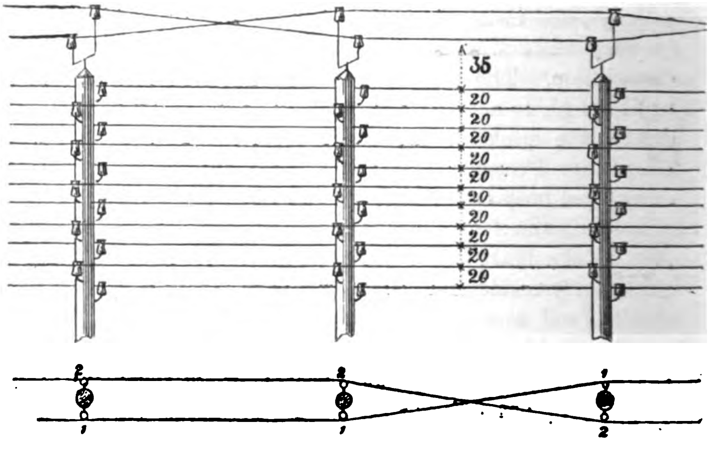

Fig. 3A.

The whole air line, 195 miles, was run in three weeks in the months of December, 1886, under great difficulties from bad weather. The length of the Belgian section is forty-eight miles. It starts from the Bourse in Brussels, and the Paris end is joined on to the Bourse there by an underground leaded cable 3 miles long.

The Belgian part of the line is run in phosphor-bronze, the French in silicium bronze. Great care had to be taken with the insulators, as good insulation was as important as freedom from induction. The system of running on the top of the poles, which had been found so satisfactory on the Brussels-Antwerp line, was adopted. But, rightly or wrongly—the author thinks the latter—the wire running department objected to the idea of the wires crossing vertically in the air, on the score of danger of wind contacts. (By a vertical cross is meant that between two poles the two wires remain respectively on the same sides of the poles, but exchange their levels, as opposed to a horizontal cross, when they retain the same respective levels, but exchange sides.)

A four-branch bracket (Fig. 4) was therefore used, so that all vertical crossings take place at the posts. The four insulators are undesirable, as every additional insulator offers an additional chance of leakage. It was found to be sufficient, however, between stations to put in a four-way bracket, and reverse vertically at every thirtieth or thirty-fifth post, and between these to reverse horizontally backwards and forwards at every sixth or seventh span, using brackets of the type already shown in Fig. 3. Fig 5 is a diagram of a portion of the line passing by the railway station at Mons, where the wires are crossed horizontally at more frequent intervals. This method does not entail cutting the wires, so that there are no more joints than in direct running.

* *Journal* Soc. Tel. Eng., Vol. VIII., 1887.

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The line was first opened on February 24th, 1884, and the public can judge whether it works satisfactorily or not. As to the engineers of the two administrations, accustomed as they are to almost daily faults on a telegraph line of such a length, they are delighted with the perfect way it conducts itself. The greater part of the

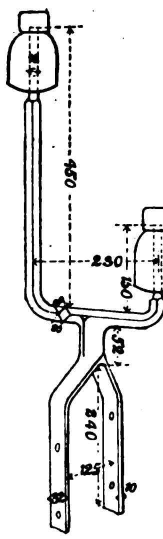

Fig. 3.

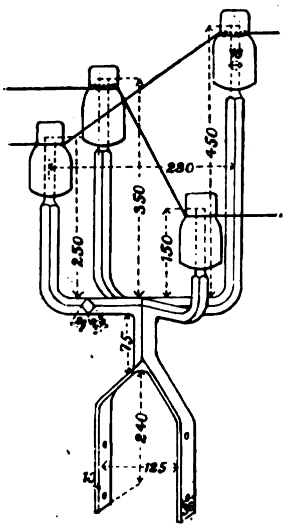

Fig. 4.

faults which have occurred have been in Brussels, where the house painters have occasionally short-circuited the overhead wires. The same wires are used simultaneously for telegraphy on the Van Rysselberghe system. The insulation and conductivity of the

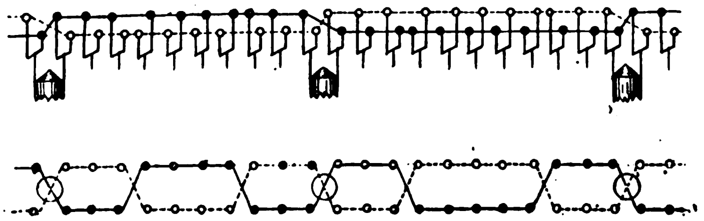

Fig. 5.

line were proved when, one winter's day, all the other telegraph wires having become unusable, the Hughes instrument got through to Paris at full speed on the telephone wires.

The two wires of the line must be alike in material and insulation. The line ceased to be silent, for example, when a Bell telephone was interposed at the frontier in one of the wires, or if one of them touched a tree branch or a damp wall.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, *Feb.* 18*th*, 1888.

Some little amusement has been caused here by the prominence given in the play "L'Abbé Constantin" to Mrs. Scott and her cable. Mrs. Scott is modelled, it is said, upon Mrs. Mackay, and enlarges upon the advantages of having a cable in the family. When one owns a cable letter writing becomes not a lost but an unnecessary art, and the effect of Mrs. Scott's eloquent presentation of the delights of cable communition is to lead many of the auditors of the piece now on at Wallack's to go out and order a cable for themselves. If this exaggeration of the playwright were allowed to pass unchallenged, there is no knowing where the thing would end, and instead of a dozen Atlantic cables there would be a gross. I understand that Mr. G. G. Ward, who looks after Mr. Mackay's cable interests so ably here, has been interviewed on the subject, and has stated that after all the Bonanza King and Queen use the cable but seldom, and then pay for every message. M. Halévy notwithstanding, Mrs. Mackay is not in the habit of chatting daily with her husband 6,000 miles off, as to her latest purchases of castles, jewels, or dresses, or her options on any duchies or principalities that happen to be in the market. This little feat of talking at 6,000 miles range is, in fact, left to Mr. Stead and his special commissioner, while the Mackays, as well as the Goulds, still find use for fine stationery, crested or otherwise.

There has been quite a row in Washington over the exposure of the fact that leading firms of stockbrokers had wires running direct from the Capitol lobbies to their Wall Street offices. Mr. S. V. White, a magnate of the "Street," was sent recently to Congress, and naturally wished to have his special telegraph service as handy as possible. He therefore did only what had been done before, but someone who was jealous mentioned the matter to a newspaper correspondent, and the result of the uproar caused is that all such wires have been ordered out by Mr. Carlisle, the Speaker of the House of Representatives. Admitting, as one may, that the wires were always put to proper uses, it cannot be open to question that Congress gains in dignity by having such wires removed; for although the connection with Wall Street was openly maintained, it was impossible to avoid suspicion and even scandal. The only wires left in are those which are necessary for public and general use, and the speculating Congressman will now have to get his quotations a little less directly.

The leading event of the past week has been the meeting of the Association of Edison Companies at Chicago. This body is composed of Edison local companies and those who may be directly interested in the same, and excludes from its membership all outside supply concerns. It is also peculiar in that its sessions are held with closed doors, in this respect being more exclusive than another body equally august—the Senate of the United States—which has both public and executive sessions. The meeting at Chicago was largely attended, and its proceedings were watched with more than usual interest, from the fact that it is the first that has been held since the alternating current boom got well under headway. I have spoken with several who were present, and who participated actively in the proceedings, and I have failed to detect any evidence of nervousness or trepidation as to the future of the Edison system, or, for that matter, as to the practical superiority of the alternating over the direct current for general purposes of distribution. As the session was held with closed doors, it is somewhat difficult for me to tell what took place, but note may be made of a few interesting facts. One of these is that Mr. Edison, departing from an almost invariable rule, and overcoming an almost invincible repugnance to the effort, made an address before the association, in which he gave an exposition of his views on the subject of direct *versus* alternating currents. I understand that Mr. Edison stated frankly his unchanged conviction as to preferability of the direct current, and indicated various ways in which that current might be rendered a formidable rival to the alternating current, even on ground which has been supposed to be the peculiar province of the latter. At the same time, and in keeping with the line of thought advanced by Mr. Edison, it would not be surprising if we were to see a little increase in the E M.F. which has hitherto been observed as the standard of the Edison system; in other words, it is not unlikely, for instance, that we shall see in use a current of 330 volts instead of 220. This, as you will plainly see, is well within the safety limit, yet makes a material reduction in the quantity of copper necessary in the mains. As to the Edison municipal system, in which incandescent lamps are now run in series, and at a potential as high as 1,000 volts for street lighting and similar work, Mr. W. J. Jenks, the able manager of that department, made a very interesting report, in which considerable progress was shown, and in which the point was brought out that in not a few cases these lights had replaced and supplanted arc lights.

Mr. J. H. Vail, the general superintendent of the parent company, presented a mass of valuable statistics of various items of central station operation, &c., and brought out the astonishing fact that on the value of dynamos in Edison stations in this country the cost of repairs has been less than $1\frac{7}{10}$ths per cent. The rate would give such machines a life

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of at least half a century. Mr. Vail also stated than in less than two years the number of Edison central stations had grown from 43 to 148, and the capitalisation of the stock companies from £550,000 to £2,300,000, on all of which as one investment an excellent rate of interest is being paid. The earning capacity of some of these stations was indicated by a number of load diagrams which he exhibited, one of these showing a maximum output of no less than 9,000 amperes.

I am told that one of the liveliest episodes of the convention was the reading of a paper by Mr. W. W. Mottram, who is the superintendent of the Edison Company at New Orleans. Not so many months ago Mr. Mottram's peace of mind was very much disturbed by the advent of the alternating system in the Crescent City, and he felt the ground crumbling beneath his feet, as though a Mississippi freshet were sapping his strongest dykes. Mr. Mottram, however, is a young Englishman, with the average amount of proverbial tenacity, and he made up his mind to see the thing through. At the Edison meeting, he stood up and related an extraordinary story of mishaps with the new system, and informed his brethren in the Edison faith that they had every reason to regard their position as a secure one. He had himself been obliged lately to increase the capacity of his station, and he thought that this would be the result in every case where the two systems came into direct competition. I need hardly say that Mr. Mottram's views were received with the wildest enthusiasm. Various points of interest were touched upon; the meter system of charging for current received a very strong endorsement, and the reports as to the growing use of current for electric power purposes were most encouraging. The Edison stations everywhere throughout the country are going into this business, finding that they can get so much greater return out of their plant, and that they can also render their day circuit profitable, instead of being a source of loss. There can be no question as to the present enormous rate of growth in the incandescent lighting field, and it is somewhat remarkable that American manufacturers are finding so large a market abroad. Mr. S. Bergmann brought out this point at the Edison meeting very remarkably by some figures which he gave as to his own export trade. A noteworthy little substantiation of the claims as to the growth here is given by the statement of one of the largest glass companies in the country that the demand on them at present for incandescent shades is as large as it is for gas shades.

I touched above, in speaking of the Edison Convention, on the alternating system, which is just now in this country a most engrossing theme of discussion. During the present year, as you are aware, the American Institute of Electrical Engineers in the papers of Prof. E. Thomson and Mr. W. Stanley, jun., has brought out some very valuable information on this subject, and another important contribution to the investigation was contributed at its meeting on Feb. 14, when Dr. Louis Duncan, of Johns Hopkins University, read a paper on alternating-current motors. Dr. Duncan, it will be remembered, was one of the experts who conducted the well-known Franklin Institute tests on dynamos and lamps, and he has recently been examining the subject of alternating currents, in connection with his work at the university. I have no doubt that you will publish the paper in full. He took occasion to point out that there were four forms of alternating motors which came within the bounds of possibility, though with widely different elements of practicability. The form which he seemed to regard as the most promising was that of an alternating dynamo reversed, the field being excited by continuous currents. Such a machine could be cheaply made. When once started it would govern itself perfectly, and it would give a greater output from a given source than the other machines of the alternating type. One of its disadvantages was that it must be brought into time, and that the field must be supplied with a continuous current, and that the motor would stop if a heavy load be applied suddenly. These difficulties, however, he would obviate in various ways. The paper was actively discussed, among others, by Lieut. Patten, U.S.A., who described an alternating current motor of his own design, belonging to the type first suggested by Prof. E. Thomson, in which the electro-inductive repulsion of closed coils or circuits, traversed by alternating currents, is made the principle of action. One point touched upon in the discussion was the use of the alternating motor for car traction; but it could not be said that there was a very deep impression as to the feasibility of its use in this department.

All the testimony is now in the suit of the Consolidated Stock and Petroleum Exchange against the New York Stock Exchange to prevent the latter from removing the commercial tickers from the consolidated building. The case has been on trial before one of the courts in Brooklyn. The contention of the Stock Exchange is that the quotations which are made on its floor are its own private property, the distribution or sale of which is a matter within its own discretion. The opposite contention is that that exchange is engaged in the sale and distribution of a necessity in the shape of financial news, and that it is trying to discriminate, unlawfully and unfairly, between those who desired to be its customers for this news, or is forcing the Commercial Telegraph Company, which is a public corporation, to discriminate for it. It will be interesting to see what the decision is. In the meantime the New York Stock Exchange, with the aid of the public authorities, is waging relentless warfare against the bucket shops, thirty of whose proprietors and *employés* were arrested at one swoop last Saturday. The agitation over this matter may perhaps seem trivial to some of your readers, but it is really of no small importance to the exchange, and this will be seen when I state that the business of St. Valentine's Day was only 46,000 shares. One has to go back as far as 1877 to find a parallel for this dulness, and then the total business of the lowest day was not quite so low, being 48,000 shares. The average day's work in ordinary times is 400,000 to 600,000 shares. You will not wonder, therefore, that the brokers are thirsting for the gore of the bucket-shop proprietors.

News has reached this city from the West Indies of the successful repair, after about three months' work, by the West India and Panama Cable Company's steamer "Grappler," of the cable between Jamaica and Colon. It is stated that the repairs have cost about £10,000; but it may console some of the holders of the company's stock to know that the original cable, laid seventeen years ago, was found, when picked up, to be in almost perfect condition. It seems to many here that a great deal might be done to improve the telegraph communication with the West Indies, though this is a matter which probably concerns England for the present more than it does this country. It is very certain that if the United States owned the West Indies the cable service would be a great deal better than it is.

NOTES FROM BRUSSELS.—THE LIGHTING OF THE EXHIBITION.

(FROM OUR CORRESPONDENT.)

It has already been announced that some of the principal firms in Belgium have formed themselves into a syndicate with the view of undertaking central station lighting. A technical committee of the syndicate has been appointed, whose first duty will be to consider the important question of the methods and appliances best adapted for use under the different conditions which may present themselves. The members of the committee are the following:—MM. Bonnevie (MM. Bouckaert and Co.) Gérard (Anspach, Gérard - Mignot), Goffin (Société Industrielle de Bruxelles), Julien (l'Electrique), and Van Rysselberghe (MM. Mourlon Frères). It is understood that the committee will recommend two schemes as fulfilling the requirements of municipalities proposing to undertake or to sanction the distribution of electricity—

(1.) Central station distribution by means of transformers of various systems—Gaulard-Gibbs, Zipernowsky, Goffin-Hoho, &c.

(2.) Central station distribution by means of high tension dynamos (Gérard system), charging secondary batteries at substations. Batteries of various systems may be employed, but probably those of M. Julien will have the preference. This last system is already exemplified in the successful lighting of the Théâtre de la Monnaie, installed by M. Gérard.

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The Japanese are about to follow the example of their Chinese neighbours by introducing the Van Rysselberghe system of simultaneous telegraphy and telephony. It appears that this determination arose from certain successful experiments which were carried out by the students in the Physical Laboratory at Yeddo. The experiments were made on the basis of the description of the system given by MM. Charles Mourlon and Buels in their writings on telephony. The perfect success of the experiments was hailed with considerable enthusiasm by the Japanese, and a well-known Belgian firm has just received an order from the Japanese Government for a complete set of apparatus for use on one of the principal telegraph lines in Japan. We may mention in passing that the Yeddo Laboratory was fitted up throughout by Messrs. Latimer Clark, Muirhead and Co.

On the Athens-Piræus and Peloponessus Railway the Van Rysselberghe system is to be installed throughout, and will replace the present method of signalling.

We have received from our Brussels correspondent an interesting statement of the electric lighting contemplated at this year's Exhibition in Brussels ; but want of space compels us to confine our present account to the principal features thereof. It is noticeable that whereas in this country the lighting of an exhibition is now usually allotted to one or two firms who undertake the work on contract, it has in this case been determined to make the lighting an important feature of the Exhibition, and therefore it has been divided amongst a considerable number of exhibitors.

The installation has been divided into three parts :—

1. The main buildings and their annexes.
2. The fountains and façades.
3. The gardens.

The main portion of the Exhibition consists of two rectangular halls originally built for the National Exhibition of 1880. These are connected by a gallery and colonnade, in all measuring above 200 metres. The central portion contains the King's Pavilion.

The Great Hall, or gallery of machinery at the rear of the colonnade, measures 250 metres in length by 68 in width and 23 in height, and it terminates in two annexes, each 100 metres long by 60 broad.

This main gallery or hall is to be lit by 84 arc lamps chosen from the systems of Piette and Krizig, Dulait, Thomson-Houston, De Puyt and Pitot.

The lamps will be suspended at heights varying from 7 to 10 metres, and from 10 to 16 metres apart.

The Salle des Fêtes, 3,000 square metres in extent, is the object of special enterprise, for which many electrical firms have submitted plans and tenders. The arc lamps to be supplied will probably number 10 or 12, with incandescent lamps of the Victoria or Swan and Edison pattern between the pillars.

In the Hall d'Honneur there will be 8 lamps of high power.

The *loges* will be lit by Bernstein lamps of 3 to 5 candle-power. MM. Bouckaert and Co. furnish 4 lights of 320 candle-power on the outer garden slopes, which will illuminate the salient features of the building. At the end of the gardens there will be two Dulait lights, 25 metres high, equal to 10,000 candles, marking the entrance of the Exhibition. The illumination is to be carried all along the Rue de la Loi. The right annexe of the Central Hall is to be served by 38 arc lamps, of from 35 to 90 candle-power, selected from the systems of De Puyt, Dulait and Piette and Krizig, and the left annexe by 30 lamps supplied by Ganz and Co. This is equivalent to one lamp per 80 square metres superficial, with 5 metres in height, or 28 candle metres intensity, which is a trifle above the average of the lighting in the machinery gallery. Eight Thomson-Houstons, placed 18 metres high, each 2,000 candle-power, will light the outer gardens of the annexes. These lights will absorb in all about 350 horse-power, leaving 150 horse-power for the lighting of the pavilion, façades, &c.

The illumination of the fountains will be entrusted either to Mr. Galloway or Messrs. Sennett and Pieper, and ultimately the lighting of the gardens and pathways will be included. Water-power will likewise be furnished to the extent of 150 horse-power for a machine in one of the courts of the Aquarium.

The Aquarium, the Kursaal, and the Great Brewery are to be lit by Pieper, of Liége. In the English section the work will be done by the old plant brought from Manchester.* No fewer than 25,000 gas jets, in festoons, are to be distributed in and about the alleys and groves of the gardens. Gérard and Co., who were among the earliest to demonstrate the practicability of the electric light for public purposes, will probably be called upon to light the Rue de la Loi.

Taken altogether we are led to expect a very substantial and effective installation in connection with the approaching Exhibition.

* We were under the impression that this plant had been sent to Glasgow.—Ed. *E.*

CORRESPONDENCE.

THE NOTATION OF MAGNETIC QUANTITIES.

[*Translation.*]

TO THE EDITOR OF THE ELECTRICIAN.

Sir : In the issue of your esteemed journal for the 24th February, Mr. James Swinburne takes me to task for a fault of which I am perfectly innocent. I appeal to the shade of Maxwell, according to whom we have hitherto imagined electrostatic resistance considered according to the theory of dimensions to be of the nature of a *slowness*—that is, the inverse of a velocity. In designating by $\mathfrak{J}$ the magneto-motive force, ϕ the flux of force, and $\mathfrak{R}$ the magnetic resistance, I had not any intention of touching upon quaternian methods ; my object was more simple and more practical. All the capital and italic letters ordinarily employed being already required to designate physical quantities other than magnetic quantities, I have simply used Greek and *lettres de ronde*—not German letters—to note the flux of force, magnetic motive force, and magnetic resistance. The vectors, scalars, and quaternions have nothing to do with these ordinary algebraic notations. But where Mr. Swinburne is archi-hypercritical is when he confounds the magnetic resistance with its inverse, the magnetic conductibility, and attributes to me an error which belongs properly to himself. I read in effect (page 412) "and R denotes the magnetic resistance which appears to be μ multiplied by the area and divided by the length of the magnetic circuit."

This definition, which Mr. Swinburne attributes to me, is that of the inverse of the magnetic resistance, a definition which latter may also be found—this time correctly given—in the same number (page 408) in an article by Prof. Geo. Forbes on "Formulæ for Converters." In this paper the magnetic resistance is defined thus

$$\rho = \frac{\text{mean length of lines of induction in the iron}}{\text{cross-sectional area of iron} \times \text{permeability}}.$$

I have designated by $\mathfrak{R}$ the same thing which Prof. Forbes calls "ρ," and Mr. Gisbert Kapp calls R, and it is difficult to understand where the difficulty lies in accepting one or other of these notations. As to an international notation, I recognise with profound regret that we are as far from it as ever.
—Yours, &c., E. Hospitalier.

STARTING THE DYNAMO ON TO THE ACCUMULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : Perhaps others, as well as myself, have experienced some little difficulty in putting the charging dynamo on to the accumulator battery exactly at the right time—*i.e.*, just when the E.M.F. of the machine is equal to the E.M.F. of the battery—and I have often seen heavy sparking at the commutators and the armatures, probably strained by the connection being made too early or too late.

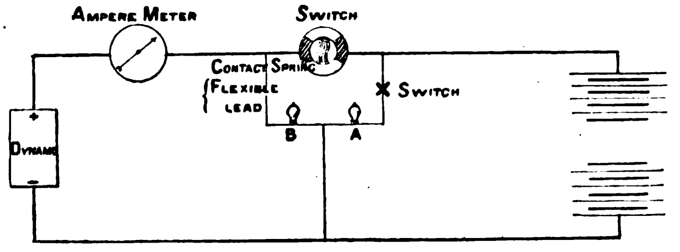

Fig. 1.

Some of the automatic appliances made for this purpose get over the difficulty to some extent, as they are generally set to make the contact when the volts on both sides are approximately equal ; but such apparatus are costly at least.

I found using a voltmeter also not so convenient as the very simple plan shown diagramatically in the accompanying sketch (Fig. 1).

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The lamps A and B are first selected as giving the same light with the same E.M.F. The lamp A, it will be seen, is lighted from the accumulators, and B is connected with the machine. If now the machine is started B will gradually become bright as the speed increases, and by watching until the light given by the two lamps is equal, and then closing the switch D, the circuit is made without the least sparking at the commutator, and without throwing any strain whatever on the armature of the dynamo; for if a double-ended current indicator be placed in the circuit it will be seen that it remains at O, with scarcely a tremor, even when closing the switch.

Here we have several dynamos which have to be coupled parallel on to the battery (the number of cells in which also varies greatly) one after another; this makes it still more difficult to use automatic apparatus. In our case the connection from lamp B is a flexible wire to attach to any dynamo switch with a spring as required.

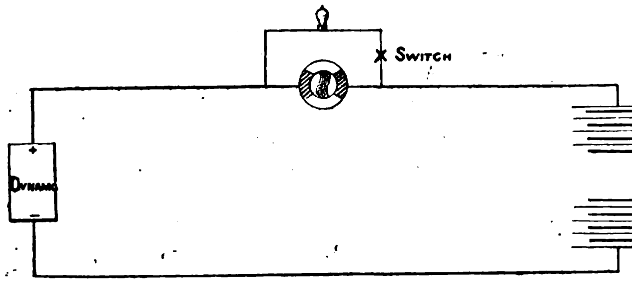

Fig. 2.

A modification of the above, which also answers fairly well, is shown in sketch (Fig. 2). In this case the P circuit is complete through the lamp, then as the E.M.F. of the dynamo rises it will oppose the E.M.F. of the battery, and the main switch is closed just as the lamp ceases to glow. In this case it is advisable to make the main switch also switch *out* the lamp when the battery is put in, in such a manner that the lamp can only be lighted again by a movement independent of the main switch.—Yours, &c., T. W. W. Melhuish.

Vienna, Feb. 25th, 1888.

ELECTRIC TRACTION: CLOSED CONDUIT SYSTEMS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. W. Geipel, p. 357 of the present volume, says:—"A plan has also been proposed by them (Profs. Ayrton and Perry) for employing the attraction of a magnet fixed on the car and keepers fixed in boxes underneath the street. The contacts on the keepers are permanently connected with the underground conductor, and when lifted by the attractive force of the magnet on the car they make connection with a section of rail putting the motor in circuit."

This is just about the description of my own and Mr. Binswanger's system, invented, designed, and patented in November, 1886.

As I know Profs. Ayrton and Perry before this date had not proposed tramways on the parallel system described, if Mr. Geipel would examine a copy of their patent of 1883, No. 2,395, p. 14, he would see at once what was their opinion of the parallel system at that date and what has been done.

But as I may not know all of the numerous works of Profs. Ayrton and Perry, Mr. W. Geipel would oblige me very much by pointing out the dates and papers in connection with the system mentioned by him.—Yours, &c., Charles Pollak.

11, Rue Descartes, Paris, Feb. 26, 1888.

THE STABILITY OF TELEGRAPH WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The education of Mr. Frank Caws as a telegraph-engineer is proceeding apace; but he has yet to learn a great deal before he thoroughly realises the conditions that determine the stability of a telegraph line. His experiments are mere repetitions of those which most responsible engineers performed for themselves more than a quarter of a century ago, but without his errors. In conducting them he has committed several fallacies, but the most serious one is that from erroneous data he has calculated a certain curve which he has caused his apparatus to reproduce, and this he calls his experimental curve.

If Mr. Caws' figures show anything at all they show that our wires have a greater factor of safety than I have allowed; but his data are wrong, his curves are wrong, and he is working in the dark. A telegraph wire is freely suspended between two rigidly fixed points. We have to regard what takes place in only one span. Omitting external stresses, the changes of form in this span are changes due to variations of temperature. The changes of strain are changes due to its own elasticity. We do not care for variations of form or of strain due to internal stresses provided we are well within the margin of safety, and all the wires in one span are affected equally and similarly. What we have to guard against are external stresses, due to wind, snow, ice, falling trees, poles and signal posts, &c., stresses often exceeding the limits of elasticity. Mr. Caws should do what engineers have done, viz., permanently fix up a span of wire and watch and record its vagaries for three or more years; he should also experiment with stresses producing the breaking strain of the wire. He will then acquire a little light on the stability of a telegraph line, and learn why the tendency is to shorten spans, to increase the tensile strength of wires, and to smile at springs.—Yours, &c., W. H. Preece.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I noticed in last week's edition of your journal that Mr. Caws, in Part II. of his article, "Experiments on the Conditions which Determine the Stability of a Telegraph Wire," gives a diagram showing how the experiments were performed. From this Mr. Caws has apparently quite forgotten the weight of the Salter's spring-balance and the linesman's vice upon the line-wire. Mr. Caws states he adjusts the nuts "so that the angles of the line-wire may be equal on both sides of the pulley, which is evidenced by the thermometer-plummet." In that case he intends to make a balance upon his plated pulley of the span of line-wire upon one side and the linesman's vice and spring-balance upon the other, without allowing anything in the dip for so doing. I think Mr. Caws has made a great mistake, and applied an impractical method, the result of which cannot be the true table of dips and stresses.—Yours, &c., Robt. S. Bozon.

INDUCTANCE AND RESISTANCE IN TELEPHONE CIRCUITS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of 3rd February you draw attention to an article in the *Phil. Mag.*, by Mr. Oliver Heaviside, in which he makes what appears to me to be a remarkable statement. I hope I shall not occupy too much of your valuable space by quoting it *in extenso* as follows:—"It seems to be imagined that self-induction is harmful to long-distance telephony. The precise contrary is the case. It is the very life and soul of it, as is proved both by practical experience in America and on the Continent on very long copper circuits, and by examining the theory of the matter. I have proved this in considerable detail; but they will not believe it. . . . It is resistance that is so harmful, not self-induction."

This appears to be so entirely contradicted by other authorities on the subject and by experiment, that I feel sure all telephonists must—like myself—wish that Mr. Heaviside would give us an explanation of his reasons which can be understood by us as well as by the talented few who can fully appreciate his article.

Prof. S. Thompson, during a discussion on this subject at the Society of Telegraph-Engineers, May, 1886, said: "The best thing to do is to keep up the resistance by using thin conductors such as silica-bronze or phosphor-bronze, at the same time keeping down self-induction by avoiding unnecessary turns in the coils and unnecessarily large iron cores." An American authority, speaking of copper wire conductors, also states that "no advantage can be distinguished in the use of

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No. 12 gauge over that of No. 18 in working the metallic circuits between Philadelphia and New York."

From actual experiments on all kinds of telephone circuits, I have invariably found that when a high resistance with little or no inductance was inserted it had scarcely any effect in weakening the received sound, but that there was a considerable diminution when a coil of comparatively low resistance but of large inductance was substituted for the high resistance.

This would appear to point to high resistance in the circuit being unimportant, and that the great point is to reduce the inductance, and I hope, therefore, that Mr. Heaviside will see his way to explain where is the fallacy of such deductions. —Yours, &c., F. B. HAWES.

THE PROPOSED LIGHTING OF THE CITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the notice in your issue of last Friday anent the proposal of the Anglo-American Brush Company to light a certain area of the City of London, will you kindly allow me to express the feelings of regret with which I learned the Commissioners of Sewers had again rejected the proposal, owing apparently to the ungallant interference at the eleventh hour on the part of the Maxim-Weston Company?

For some time past I, as one deeply interested in the introduction of the electric light to Dublin, have been watching with no little anxiety the progress of this proposal, believing that its final acceptance would be the means of imparting a considerable impetus to the electrical industry.

It is much to be regretted that those praiseworthy negotiations (now extending, I believe, over some years) to undertake an interesting and highly important work on a legitimate and properly considered commercial basis, should be as it were invaded by the overtures of a practically untried company, whose electrical apparatus has not, as yet, come very conspicuously before the public.

It would have been very much more conducive to the interests of the electric light generally if Mr. Watt's company had gracefully stood aside and allowed the work in question to be carried out without obstruction by those who had spent so much time and energy in working the matter up to its present position.

I believe that until some such general scheme as that proposed is in practical operation in London, we in the provinces shall have to wait a long time before our desire to see the new illuminant installed in our streets and houses is gratified.

Therefore it is that I earnestly hope the City Commissioners will reconsider their decision of Tuesday last, and find it to their advantage to come to terms without delay for a grand scheme of electric lighting on a sound commercial basis.—Yours, &c., ANGELO FAHIE, M.S.T.E. & E.

SHALLENBERGER'S SYSTEM OF STREET LIGHTING BY ALTERNATING CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of January 13th, 1888, you refer to Mr. Stanley's mention of M. Shallenberger's system of street lighting. Some months ago while doing some work upon an electrical instrument, in which I was using a self-induction coil in series with a dead resistance, I noticed the same apparent increase of E.M.F. mentioned by Mr. Stanley.

After making several tests to find the cause of this increase, I arrived at the following explanation, which I believe correct:—

I can best state the solution that I arrived at by assuming a special case and endeavouring to explain it. Let us suppose that we have a series of four 50-volt lamps across a 200-volt circuit, as in Mr. Stanley's example. Each lamp is shunted by a self-induction coil. Suppose that the E.M.F.'s are all to be measured by a Cardew voltmeter.

The current taken by a Cardew voltmeter increases nearly as the E.M.F. which it measures. The heating effect upon its wire, it must be remembered, increases as the square of this current. When all the lamps and coils are in place the voltmeter will indicate 200 volts as the total E.M.F., and 50 volts as the portion of this total acting upon each lamp.

The self-induction of the four coils is so high that practically no current is taken by them; but let one of the lamps be removed and the conditions are changed. We will consider the effect of this change during one wave phase.

First, let the E.M.F. of our alternating current be passing from zero to some definite value. The self-induction coil from which the lamp has been removed will now receive more than its share of the E.M.F. of the circuit, being in series with coils that are shunted by lamps. But the coils are so constructed (as to amount of iron and length of wire) that the increased E.M.F. to which the unshunted coil is exposed soon overcomes its power of self-induction [? the iron core is magnetised to saturation.—ED. *E.*], this taking place before the wave of E.M.F. is completed. The iron of the coil having once exerted the full inductive effect of which it is capable permits the remainder of the current produced by the E.M.F. impulse under consideration to pass the coil practically at a short circuit. The ohmic or dead resistance of the wire of the coil may be made very small, as compared with the resistance of the lamps, and will be disregarded at present.

To express the above idea in fewer words, I would say that the increase of E.M.F. upon one coil that occurs when it is placed in series with three shunted coils overcomes the self-induction of the single coil before the reversal of the current has taken place. After the self-induction of the coil is overcome the total potential of the circuit is divided between three lamps and a low-resistance wire—the wire of the unshunted coil. If the coil has been properly constructed about one-quarter of the energy of the E.M.F. wave was spent in overcoming its self-induction, and we will assume that this energy was expended upon the coil in one-third of the time of the wave phase.

During the remaining time of the wave there will be sufficient current pass in the circuit (owing to the self-induction factor having disappeared in the resistance of the unshunted coil, and to the heating effect of the current upon the lamps increasing as the current squared) to keep the remaining lamps at full candle-power.

It is evident that a Cardew voltmeter measuring the E.M.F. at the terminals of the working self-induction coil would have received during a portion (assumed to be one-third) of the time of the E.M.F. wave three or perhaps nearly four times as much current as it would have received during the same time if the potential of the circuit had been evenly distributed between the four-lamp resistances, because the counter E.M.F. of the coil offered a high or nearly infinite resistance to the passage of the current until its effect was overcome. This increase of current in the voltmeter to about three times its normal amount for one-third of the time of a wave phase gives a heating effect upon the wire of the voltmeter nine times as great as it would have been if the potential had been evenly distributed. But to get a reading of fifty volts we should have only three times as much heat, or $\sqrt{3}$ times as much current for one-third of the time of the E.M.F. wave as with the even distribution of potential.

The generation of heat during one-third of the time of each E.M.F. wave, nine times as fast as is required to give a deflection of 50 volts on the voltmeter, produces three times as much heat in the voltmeter wire as gives a reading of 50 volts, or about as much heat as would be required to give a reading of $\sqrt{3} \times 50$ volts.

During the fall of potential from a positive or negative value to zero there is no difference of potential required to keep up the current in the working self-induction coil (disregarding the dead resistance of the wire of the coil). There is not only no counter self-induction during the fall, but the coil may even add slightly to the E.M.F. of the circuit. The same cause that produces an after current giving rise to a discharge spark when a circuit exciting a large electro-magnet is broken, produces in the case of a self-induction coil an after current, tending to keep up the E.M.F. of the circuit when the potential is changing from a positive or negative value to zero. This discharge current, if its effect is sufficient to be

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noticed, will unite with the other causes in making the voltmeter read too high.

For the above reasons it would occur that in measuring the E.M.F. at the terminals of the coil from which the lamp has been removed with a Cardew voltmeter a false reading is obtained, while a voltmeter measuring the potential at the lamps will read 50 volts for each lamp if the 50-volt lamps are at candle-power. The reading of the voltmeter must be 50 volts when the lamps are at candle-power, since the light given from the lamp and the reading of the Cardew instrument both depend upon the heating of a conductor, carbon, or wire.

I have disregarded the effect of the current taken by the voltmeter upon the distribution of the potential, and also the effect due to the leakage of the three shunt coils. The leakage of the three coils shunting the lamps is very slight, as they are not subjected to sufficient E.M.F. for a long enough time to overcome their self-induction. In this connection I have made several series of measurements, showing that the leakage current in a self-induction coil increases very rapidly, as the E.M.F. upon the coil increases, if the coil is working near the point of magnetic saturation of the iron.

The argument that I have presented must be somewhat modified in practice on account of the rise and fall of potential being gradual, and not abrupt. This consideration is especially involved when it is assumed that one-third of the time of the wave phase is consumed in overcoming the self-induction of the unshunted coil, one-third being only an approximate value for the special conditions considered. I hope, however, that what I have said will serve to express the idea aimed at. A series of twenty 50-volt lamps can be so arranged with shunt coils that one broken lamp will not only be replaced by its coil, but the total resistance of the series to the alternating current will be so modified when one lamp breaks that the remaining nineteen lamps will burn more brightly than before the twentieth lamp broke.

In practice, in the Westinghouse Electric Company's street lighting system three or four out of a series of twenty lamps arranged with shunt self-induction coils can be removed before the remainder become perceptibly dimmer; yet there is reason to believe that the total energy consumed in the circuit is reduced each time a lamp is taken out of the series.—Yours, &c., FREDK. DARLINGTON.

Allegheny City, Penn.

[We believe our correspondent's explanation to be the correct one.—ED. *E.*]

THE DEPOSITION OF ALUMINIUM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of February 3rd, you refer to the deposition of aluminium electrolytically and give a receipt as set forth by Mr. Herman Reinbold. I should be very much obliged if you could give me any reference as to where I could get fuller particulars. I tried the receipt and entirely failed in getting any aluminium deposited, whatever the strength of current was.—Yours, &c., R. H. C. NEVILE.

Wellingore Hall, Grantham, Feb. 18, 1888.

[Perhaps some of our readers can give our correspondent the benefit of their experience.—ED. *E.*]

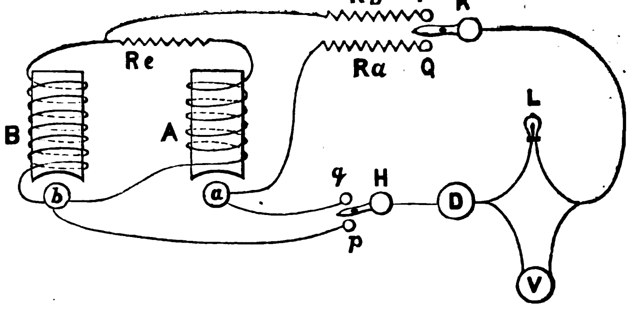
PHYSICAL SOCIETY.

At the meeting of this society on Saturday, Feb. 25, Prof. Ayrton communicated a note by himself and Prof. Perry,

"ON THE EFFICIENCY OF INCANDESCENT LAMPS WITH DIRECT AND ALTERNATE CURRENTS."

Prof. AYRTON stated that the object of the experiments described in the present communication was to determine whether, for a given amount of power supplied to an incandescent lamp, a larger amount of light would be obtained by using direct or alternate currents respectively; in other words, which of these systems, direct or alternate currents, would be the more advantageous to the householder paying a stipulated amount for each Board of Trade unit? To solve this question a large number of experiments was made, in which the light of a lamp supplied with direct and alternate currents respectively was compared with the light of a standard candle.

The arrangement employed is shown below:—



A Alternate current (Ferranti) dynamo; *a* its armature.
B Direct current (Gramme) dynamo; *b* its armature.
D Dynamometer. V Voltmeter. L Indandescent Lamp. H and K Switches. P*p* and Q*q* Terminals. R*a*, R*b*, R*e*, Adjustable resistances regulating alternating and direct current dynamo circuits and Ferranti exciting circuit respectively.

The Gramme machine was used, as indicated in the diagram, to excite the Ferranti alternate-current dynamo. By means of the switches K and H the lamp circuit could be connected with the Gramme machine through the terminals P and *p*, the Ferranti being at the same time thrown out of the circuit; and it also could be connected with the Ferranti machine through the terminals Q and *q*. The current supplied to the lamp was regulated by means of the adjustable resistances R_a and R_b, and the exciting current of the Ferranti machine was regulated by the adjustable resistance R_e. The reflecting dynamometer used was constructed with very fine wire to eliminate the error which would otherwise arise from want of uniformity in the distribution of current in the wire, and it was sufficiently delicate to have measured a much smaller current than was actually used. It was therefore necessary to use a large controlling face in order to keep the spot of light upon the screen. The potential difference between the lamp terminals was measured by a voltmeter of the improved Cardew type, recently devised by the authors. The actual measured value of the watts supplied would be given for the alternate currents by the product of the readings of the dynamometer and the voltmeter, namely, the product of the square root of the mean square of amperes into the square root of the mean square of volts. The result so obtained is, however, higher than the true value on account of the effect of self-induction in the dynamometer.

The true value had to be calculated from the formula—

$$\frac{\text{number of true watts}}{\text{number of measured watts}} = \frac{r\,\tau}{\sqrt{L^2\,\pi^2 + r^2\,\tau^2}},$$

or,

$$\text{true value of watts} = \frac{r\,\tau\sqrt{\overline{V}^2 . \overline{A}^2}}{\sqrt{L^2\,\pi^2 + r^2\,\tau^2}},$$

where $\overline{V}$ is the mean value of the potential in volts, $\overline{A}$ that of the current in amperes, r is the resistance of the dynamometer, and L its coefficient of self-induction, and τ is the period of alternation. The photometer used was a divided paraffin disc photometer, the disc consisting of two half discs of paraffin separated by silver foil. In order to eliminate a possible error arising from irregularity in the standard candle the observations were made in series with the two machines alternately. In the first experiments an Edison-Swan lamp was used. These observations, however, had to be rejected, as it was found that an error had been introduced by the induction of a metallic box containing the damper of the dynamometer. In the subsequent experiments this was replaced by a wooden box, and as it was feared that the filament, which in this lamp is in the form of a loop, might have a sensible amount of self-induction, Maxim-Weston lamps, having an M-shaped filament, or lamps with an ordinary horseshoe filament, were used. Observations were made with red and green as well as with white light, by the use of ruby-red and signal-green glass, and the speed of alternation was varied from 1-150th to 1-480th of a second. The result of the experiments was that no difference could be detected between the amount of light obtained from the direct and alternating currents respectively, provided the power, properly measured, was the same in each case.

The result of 75 observations gave 3·3989 for direct currents, and 3·3955 for alternate currents, as the amount of light obtained from the lamp in terms of the standard candle for a power of one watt.

The Professor remarked that very probably the life of a lamp

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might be shorter with alternate currents, but there are at present no reliable data to determine the question. He stated that he had seen tables professing to give such data, but they appeared to be mere arithmetic not founded upon experiment, and in one case the results given virtually implied that experiments had been made by the author of the table not merely before incandescent lamps had been invented, but before the supposed observer was born. Prof. Ayrton also mentioned that it had been stated that the use of an accumulator makes the life of a lamp longer than when supplied direct from the dynamo, even if a direct-current machine were used, but he was not aware that there were sufficient data available to warrant the conclusion.

In a paper read before the society in February, 1885 (*Phil. Mag.*, April, 1885), the authors found that the amount of light given by a lamp supplied by a direct current is given approximately by a formula of the form

$$l = a\,(V - b)^3,$$

where l is the amount of light, V the potential difference between the lamp terminals, and a and b are constants, b being the lowest value of V at which the filament begins to be luminous. This is for white light; for green light they find that

$$l = a\,(V - b)^{4 \cdot 44}.$$

In red light, on the other hand, the index is less than 3, but they have not yet succeeded in getting a satisfactory determination.

The authors calculated the amount of light which would be given by a lamp supplied by alternate currents, on the assumption that the proper value to be given to V was its mean value, and the square root of its mean square respectively; but in neither case were results obtained in agreement with the formula found to hold in the case of direct currents.

Mr. SWINBURNE stated that he had found a difference in the light obtained in the case of direct and alternate currents. He did not think the self-induction of the loop of an Edison-Swan lamp would be of sensible amount with currents much below 400 to 500 amperes. He did not find that the current density in the filament had any effect on the resistance of the lamp, but that it only altered the temperature of the filament. He suggested that no allowance had been made for the capacity for heat of the filament known experimentally to exist. He thought that the life of lamps would be greatly increased when better governors were available.

Prof. S. P. THOMPSON remarked that while the experiments showed that the total power was the same for given brightness, it would be of interest to know if both the factors of the work remained the same, namely, whether the average resistance of the lamp was the same in each case. The central portion of the filament would appear to be hotter than the external portion, so that there would be a different current density at the centre, and this would doubtless vary in the case of direct and alternate currents. It would not necessarily follow that there would be a similar difference for the outside portion, so that the light might be the same in each case.

He stated that he had noticed a periodic variation in the light from alternate currents, and when at an hotel had often moved a mirror backwards and forwards in front of a lamp which would show this variation if it existed, and therefore give a means of knowing whether the machine in use was an alternate or direct-current dynamo. This period, however, was much longer than the period of alternation, and he had on a previous occasion pointed out that any want of symmetry in the field-magnets of the dynamo would give rise to a periodic variation in the E.M.F., the period being equal to that of rotation. He thought that attention ought to be given to the improvement of photometers, and in the instrument used he pointed out that when the disc was moved from or towards either source of light the rays from that source would fall on it at a different angle, so that if the illumination were balanced at the centre it would not be so at the edges.

He had found great difficulty with standard candles, as he had found that the brightness depended on the length of the wick, and that when the candle was snuffed the brightness was increased by a considerable percentage.

Supposing the light varied periodically, we should then have to consider how the eye integrated the impressions received. Fechner's law might in general be held to give approximate results, but we did not know how far it would apply to rapid changes; fortunately however, the specific heat of the carbon filament prevents any serious alteration in brightness.

Mr. BOYS stated that Prof. Guthrie had made photometric experiments which showed that the eye did integrate properly the impressions which it received.

Prof. PERRY stated he and Prof. Ayrton had made remarks to the same effect as those of Prof. Thompson on the physiological aspect of the question when Prof. Guthrie's experiments were described, and in answer to a question asked (by Prof. Perry) at the Royal Society on that occasion Captain Abney stated that he had found that Prof. Guthrie's photometer gave perfectly accurate results.

Prof. AYRTON said that he understood Mr. Swinburne to say that he got different dynamometer indications for the same amount of light in the case of direct and alternate currents respectively, and suggested that this was probably due to errors in the dynamometer. The dynamometer used by them was especially constructed to ensure extreme accuracy, and waste of power was of no importance, but ordinary dynamometers for commercial purposes were usually constructed of thick wire, so as to waste as little power as possible. He stated that when he had been at Chatham Captain Cardew had told him of such a difference in the dynamometer indications, but their experiments carried out with special precautions and a specially constructed dynamometer showed that the amount of light was the same for a given expenditure of power with either alternate or direct currents.

He quite agreed with Prof. Thompson's objections to the photometers in use and to dependence on standard candles, but these would not have any effect on the present experiments, owing to the plan adopted of making a rapid succession of alternate observations with the two dynamos.

Prof. PERRY, in reply to Prof. Thompson's remarks on the slope of temperature from the inside to the outside of the filament, stated that, in 1874, owing to a letter in *Nature* calling in question Dr. Macfarlane's results on the radiation of copper spheres, on the ground that he had not taken account of the internal conductivity, he had made a series of experiments carried out with great care, and had found that it had no appreciable effect on the radiation, and he believed the same would hold good for the lamp filament. Prof. Ayrton considered that the conclusions usually drawn from Balfour Stewart's radiation experiments are erroneous, and that really white bodies emit more light, when heated, than black ones, so that it would be advantageous to use some white substance for the filament itself, or to coat the filament with such a substance. He mentioned that Mr. Bottomley had shown experimentally that a bright platinum wire gives more light than a blackened one.

Prof. AYRTON stated that he was endeavouring to carry out this idea.

SWITCH-BOARDS.

We illustrate herewith some switching apparatus designed by Drake and Gorham, and made by the United Electrical Engineer-

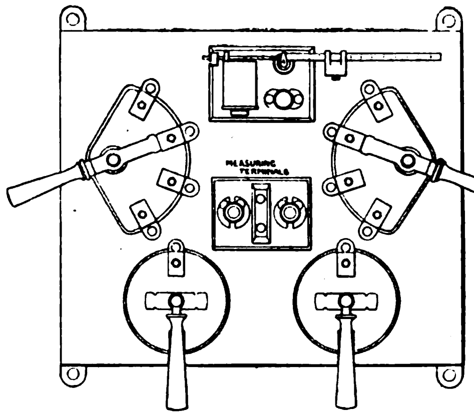

FIG. 1.

ing Company, and which have been approved by use on various important installations. The standard types are specially adapted for use with accumulators, but varieties are supplied combining all the accessories required in particular cases. Fig. 1 shows the arrangement. It includes two regulator switches, "charging" and "discharging," the dynamo being joined up to the "charging" switch, and the line circuit to the "discharging" switch. The last four accumulator cells are joined up respectively to the contacts of both switches, the obvious advantage of this arrangement being that the dynamo and lamps can be joined up independently to any of the last accumulator cells and any desired combination can be thus effected. There is also an "on" and "off" switch for both dynamo and lamp circuit, and a plug-measuring block by which the dynamo current or the current going to line can be measured.

Fig. 2 is a section showing connecting socket, into which the necessary connections are sweated at the backs of the switch-boards, thus ensuring the utmost possible safety and complying with insurance requirements.

The latest form of regulating switch is shown in Fig. 3. While charging and discharging it is frequently necessary to vary the number of cells in circuit; these switches effect this without short-circuiting or perceptibly interrupting the current. The special form

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of the ring ensures thoroughly good contact, and the adjusting arrangement preserves their efficiency for practically any length of time.

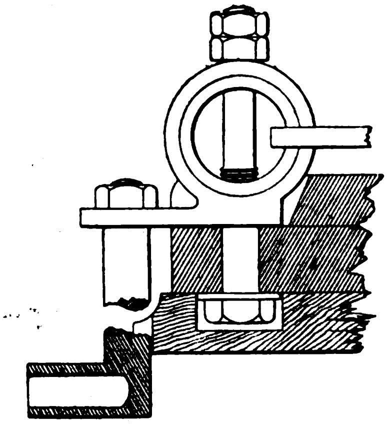


Fig. 2.

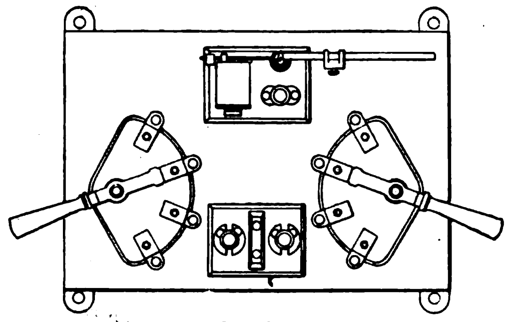


Fig. 3.

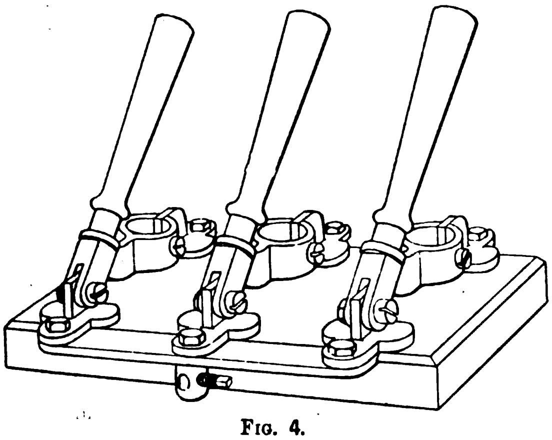


Fig. 4.

Fig. 4 illustrates a new application of the adjustable ring contacts to branch-line switches, which are used on the switch-boards to control the various circuits.

PHOTOMETRY.—THE PENTANE STANDARD LAMP NO. 2.

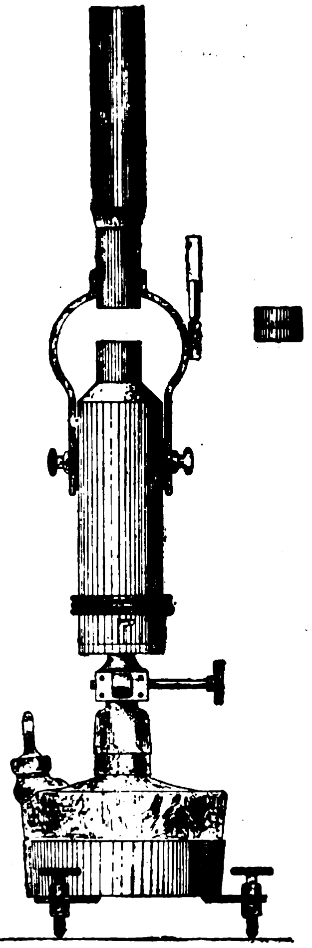
We have recently had occasion to draw attention to the pentane standard lamp devised by Mr. A. Vernon Harcourt and made by the Woodhouse and Rawson Electric Manufacturing Company.

The excellent work done by this lamp has been shown by Mr. W. T. Dibden in his Report upon Standards of Light to the Metropolitan Board of Works, in which the lamp stood at the head of all the standards tested, and yielded the exceedingly good average of 97 per cent. of tests within 1 per cent. the mean value, a result we take it never before reached by any standard tested under similar conditions.

We understand that Mr. Harcourt's aim in devising this lamp was to produce a portable and self-contained instrument, dispensing with some of the more bulky apparatus employed in his well-known pentane standard.

Notwithstanding the excellent results attained by this lamp, Mr. Harcourt believed he could construct a lamp on a somewhat different principle which would be equally exact and more easily managed. This new form of lamp he exhibited before the Physical Section of the British Association at its meeting in Manchester this year. The new lamp has been put into the hands of the makers of the former lamp, and we append a sketch of it. The new form of lamp instead of burning a mixture of air and pentane burns pentane vapour only, and though unprovided with any glass chimney round the flame burns steadily, even when exposed to moderate draughts. At the same time, the important condition that the colour of the flame produced by the direct combustion of the rich pentane vapour should be as white as possible is accomplished, as will be shown by the same apparatus.

It will be seen from our sketch that the lamp takes a form some what similar to an ordinary spirit lamp with an additional metal chimney above. The metal chimney, by producing a strong upward draught, serves a two-fold purpose ; (1) the flame is kept



exceedingly steady, and (2) the temperature of combustion is raised and a whiter light is produced.

It will also be seen that a wick is employed, which would be a distinct disadvantage were it used, as wicks generally are, within the flame or close to the point of combustion of the vapour ; but in this case the wick remains at a distance of two or three inches from the point of ignition, and serves only to convey the liquid pentane by capillary action to a part of the tube in which it is volatilised by the warmth conducted downwards from the flame. The wick, it will be observed, is enclosed in a tube, in which it fits comfortably, and which is open at the upper and lower ends. This tube is jacketed by a larger tube, to which it is attached by flat plates. This jacketing serves to produce a steady temperature of the liquid and vapour contained within it, the vapour burning as it is produced at the upper extremity of the tube. These two tubes are further jacketed by another larger one, the upper portion of which is contracted into a smaller tube, which is of the same size as the lower portion of the chimney.

The chimney itself is enlarged in its upper portion, and is attached by two metal bands to the exterior of the larger part of the lower tube. The bands are so shaped as to be at some distance from the flame, and, by means of slots cut in their lower portion, the chimney of the lamp can be moved up and down within the necessary limits. The lower tube is removable, and is attached to a gallery (solidly fastened to the base of the lamp) by a bayonet joint.

The action of the lamp is as follows :—On removing the lower tube and warming the inner tubes the pentane vapour rises from the opening in the small tube and can there be lighted. On putting on again the large tube with the chimney attached the flame rises

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above the top of the edge of the lower tube, and by slightly raising the wick the top of it passes into the chimney. In this chimney two narrow slots of 10mm. high are cut diametrically opposite to each other, so that the tip of the flame may be seen through either of them. When the movable chimney is set at a definite height above the upper edge of the lower tube, and the flame is raised so that its tip is seen to be somewhere between the upper and lower limits of the slots, the central portion of the flame appearing between the upper edge of the lower tube and the lower edge of the chimney gives a definite quantity of light.

It is well known that the light emitted from the centre of a flame is little affected by considerable variations in the height of the flame. With the flame of this lamp Mr. Harcourt has found experimentally what part is of the most constant brightness and what variation in the height of the flame may be made without affecting measurably the brightness of this part. The actual position of the interval between the lower tube and the chimney, and the length of the slot opposite to any part of which the tip of the flame may be, are the outcome of these experiments. Mr. Harcourt has found, and his results have been confirmed by subsequent experiments at the makers' factory, what portions of the flame must be selected to give a light of one candle or 1½ or half-candle, as may be preferred.

Of course any intermediate values can also be obtained by setting the chimney at various heights above the lower tube, and thus altering the amount of light visible between the upper and lower tubes.

The method for accurately setting the height of the chimney is both ingenious and simple; in fact, it forms one of the most attractive features of the lamp. Small gauges of accurate height, and exactly fitting the outside diameter of the upper and lower tubes, are inserted between them; the chimney is lowered until it rests firmly and securely upon the gauge; it is then screwed tightly to the lower cylinder by means of set screws, and the gauge is withdrawn horizontally, leaving, of course, a distance between the two tubes exactly equal to its height. In the case of the gauge requisite to obtain half a candle it is found necessary to add a small collar upon the lower tube, so as to ensure a portion of the flame being used which will remain perfectly constant, even though the height of the flame vary within the prescribed limits. This variation of the height of the flame is found to be exceedingly small after the lamp has been alight for ten minutes or a quarter of an hour and the inner tube has reached a constant temperature, the constancy of which temperature is greatly increased by the method of double jacketing which has been employed.

In order to make the instrument thoroughly accurate, as well as convenient, the inventor has added a base with levelling screws and a simple and efficient method of levelling the lamp, in addition to which he has provided a small piece of glass suitably fixed to reflect the upper portion of the flame visible through the slots, so that its position with regard to the slots may be verified at any time by an observer towards whom the face of the lamp is turned.

The colour of the light is such as to make photometry of ordinary gas lights exceedingly easy; in fact, it is nearly the same as that of the pentane flame, against which no such objections have ever been made on the ground of colour, as have been made in the case of the well-known amyl acetate lamp.

The lamp has been well tested in exposed positions, and has stood the tests remarkably well, the flame resembling a luminous pencil more nearly than an ordinary flame.

Mr. Harcourt pointed out before the Physical Section of the British Association that owing to the employment of an upper and lower cut-off it is impossible to measure distances from any portion of the flame or any point in front of it, so that the law of variation of light according to the inverse square of the distance should exactly hold; but he stated that if distances are measured from a point midway between the axis of the flame and the face of the cut-off the errors from this cause are perfectly negligible at all distances not less than 10in., and he has ensured this point being easily found by making the metal bands which unite the chimney and lower tube of half the width of the cut-off tube, and by cutting two slots in these bands into which a metal plate can be slipped. The lamp can thus be brought into its true position either by setting the edges of the bands when the lamp is at the right height between two plumb-lines lying in a plane perpendicular to the photometer bar and passing through its zero, or by direct measurement from the face of the metal plate.

The work done by Mr. Harcourt towards the production of a thoroughly reliable standard of light and the success which has attended his previous efforts are sufficient guarantee that the new form of lamp will not only prove a thoroughly reliable instrument, but will be found not less accurate than the previous forms invented by him; while the practical experience of the makers of the lamp and their well-known accuracy in the production of scientific instruments will ensure the lamp being so made as to bear successfully the test of everyday work. We may add that this burner can be obtained from the Woodhouse and Rawson Electric Company.

THE ELECTRIC LIGHT IN BRADFORD.

Dr. Hopkinson has now issued his report upon the electric lighting scheme for Bradford. It appears that of the two sites available for the generating plant—one in Bolton-road and the other at the junction of Godwin-street and Sunbridge-road—he has no hesitation in recommending the one in Bolton-road. With regard to the system of lighting, he points out that for central station lighting a variety of systems are available, and after explaining some of them, he says, "We are, then, reduced to the ordinary direct system of distribution. This system presents the advantage that a continuous current is used available at pleasure for charging accumulators or for transmission of power. The direct system may be applied in two ways—either the simple two-wire system or the three-wire system. The latter enables a double potential to be used with the same facility for turning out the lights singly, and it is specially adapted to distribution at such a distance that the mains on the two-wire system become costly, but that it is still not wise to introduce transformers. In the present case, comparing with the two-wire system, the three-wire system would save about 12 per cent. of the electrical power, with a proportionate saving in the cost of engines and dynamos. It would also effect a considerable saving in the cost of conductors. I have therefore no hesitation whatever in recommending its application in the present case. At the same time the distance is not so great that the two-wire system is wholly inapplicable, and if the engineer in charge of the work has a strong preference for postponing the introduction of the three-wire system I would not advise that his responsibility should be diminished by insisting upon its immediate introduction." Dr. Hopkinson adds that the patent for the three-wire system in this country is his own, and that the committee might therefore make such allowance as it thought fit for any possible bias on his part in its favour. If the site in Bolton-road, with its extensive area, were selected, then he would advise the use of Lancashire boilers, with Galloway tubes. Precisely the same consideration would apply in this case as would apply to the boilers for a mill. He thinks that the Lancashire boiler would be adopted for a mill by practical men without the slightest hesitation. With regard to the steam engines, he says that the primary question is—Should the dynamo machines be driven direct with a separate engine to each machine, or should they be driven by belts or ropes from engines running at a slower speed? Dr. Hopkinson considers that a separate engine for each machine is best. Referring to dynamo machines, he says he would incline to the use of five, delivering about 50,000 watts each at the lamps; but, at the same time, the use of a smaller number of larger machines would be perfectly successful, and would possess certain advantages over the larger number of smaller machines. It is very important, he says, that the amount of the electrical supply produced by the machine should be as high as possible, and adds that machines have been built which convert 93 per cent. of the mechanical work applied into electrical work useful outside of the machine. The contractor for the dynamo machines should undertake to give the Corporation a commercial efficiency of at least 90 per cent. Speaking broadly of the system of laying the cables, he points out that there is the choice of three systems. First, the Corporation might use armoured cable—that is, cable protected on the outside by a sheathing of iron wire; they might use pipes of earthenware or iron; or they might lay the cable in brick trenches. Dr. Hopkinson expresses the opinion that the brick trenches would be the best. With regard to the method of charging, he asks is the Corporation to charge by meter or by special agreement with customers. "It is," he says, "very much more costly to store electricity than to store gas, consequently you must provide a plant competent to meet the maximum demand. A consumer, then, who takes his supply for half an hour at the time when the demand is a maximum, will cost you as much as a consumer who takes the same supply during seven or eight hours provided those hours are the hours when the demand falls short of the maximum. You must keep your machinery running, and the only difference between running with a fair load and light is a small addition to your coal bill. Again, although there are many meters which will measure electricity, they are more or less costly, and sufficient time has not yet elapsed to test them for wear and tear. . . . I should therefore advise, at first, at all events, that you should charge by agreement with the customer. The basis of this agreement should be the maximum which the customer will take. You would put an instrument upon his service main which would cut him out if he seriously exceeded his maximum." With regard to the hours of work, Dr. Hopkinson considers that it would be best to begin by running from a little before sundown until perhaps one or two o'clock in the morning. The hours could be extended to an extent justified by the demand. In his judgment the Corporation should not undertake the fitting up of houses for the electric light; but it should keep the most absolute control over the way in which the wiring was done.

The recommendations given above will in all probability be adopted by the Corporation. In order to see the practical working of installations Alderman Fredk. Priestman, Mr. D. Barker, Alderman Beaumont, Mr. R. W. Silson, and Mr. F. W. Hill visited London and Leamington last week, and the result of the visit was that they were confirmed in the opinion that they were about to adopt the best known system for lighting the town. Mr. Shoolbred is proceeding with the plans and specifications, some of which are in an advanced stage. It is hoped that in a week or two the specifications will be placed before the committee, and tenders will then be advertised for. The committee will advertise in detail, with the hope that it may be able to have the work begun and completed, if possible, by one firm of contractors. It is intended to have the work done in such a way that whatever improvements may be found necessary may be made at any time.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

2,420. W. H. SCOTT and C. A. PARIS. London. An improved method and apparatus for effecting the regulation of electrical currents. February 17, 1888.

2,488. R. LANGHANS. London. Improvements in the manufacture of illuminating conductors for incandescent electric lamps. February 18, 1888.

2,449. O. ALLEN. London. Improvements in systems of and mechanism for electric railways. February 18, 1888.

2,450. W. HIBBERT. London. Improvements in electrical measuring instruments. February 18, 1888.

2,454. W. MOSELEY. London. Improvements in the insulation and method of fixing electrical conductors. February 18, 1888.

2,515. J. FEAVERYEAR. London. Improvements relating to dynamo electric generators and motors. February 20, 1888.

2,516. G. MIOT. London. A new or improved apparatus or inductometer for measuring the intensity of a magnetic field. February 20, 1888.

2,586. R. KENNEDY. Glasgow. Improvements in and relating to incandescent electric lamps. February 21, 1888.

2,654. J. A. KINGDON. London. Improvements in the regulation and control of dynamo electric machines and in apparatus therefor. February 22, 1888.

2,666. J. V. SHERRIN. London. Improvements in dynamo machines and electromotors. February 22, 1888.

2,667. J. V. SHERRIN. London. Improvements in primary batteries. February 22, 1888.

2,689. A. F. ST. GEORGE and C. R. BONNE. London. Improvements in the construction and method of arrangement of electrical incandescent glow lamps. February 23, 1888.

2,690. L. BERRY. Sheffield. Improvements in apparatus for indicating the depth of water in reservoirs or tank by electricity. February 23, 1888.

2,694. W. F. C. WARD. London. Improvements in batteries. February 23, 1888.

2,695. S. MILLER. London. Improvements in electric lighting. February 23, 1888.

2,698. E. P. DOVE. Bradford. Improvements in the construction of sanitary and magnetic mattresses. February 23, 1888.

2,726. A. T. KINNINMONT and W. H. GASTRELL. London. Improved means of laying electric light conductors. February 23, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

February 25, 1888.

2,819. H. NERLINGER. Germany. An improved method of combining and arranging apparatus, operating electric lamps for signalling, and other purposes. February 23, 1887.

2,825. J. G. STATTER. London. Improvements in or applicable to dynamo-electric machines. February 23, 1887.

4,549. A. FEATHERSTONHAUGH, jun. London. Improvements in electric incandescent lamps. March 26, 1887.

5,199. W. LOWRIE and C. J. HALL. London. Improvements relating to the distribution of electrical energy for purposes of locomotion. April 7, 1887.

5,303. H. W. RAVENSHAW, W. T. GOOLDEN, and A. P. TROTTER. London. Improvements in dynamo-electric machines. April 12, 1887.

5,505. H. W. RAVENSHAW, W. T. GOOLDEN, and A. P. TROTTER. London. Improvements in dynamo-electric machines. April 15, 1887.

5,637. A. SIEMENS and E. F. H. H. LAUCKERT. London. Electrical controlling apparatus. April 18, 1887.

5,833. F. W. CROSSLEY. London. A combined gas motor engine and dynamo-electric machine. April 21, 1887.

6,177. A. MARCILHACY. London. Apparatus for adapting electric lamps to the helmets of divers. April 27, 1887.

14,204. J. R. HARD and T. WILSON. London. Improvements in medico-electrical apparatus. October 19, 1887.

1,078. S. BERGMANN and J. T. DEMPSTER. London. Improvements in switches for making and breaking electrical circuits. January 24, 1888.

PATENTS SEALED.

February 17, 1888.

1,952. A. F. DEWER and F. WILSON. London. An improved electric switch. February 8, 1887.

1,993. E. HERMITE, E. J. PATERSON, and C. F. COOPER. London. Apparatus for electrolysing bleaching solution. February 8, 1887.

2,128. F. H. W. HIGGINS. London. Improvements in printing instruments suitable for the receiving instruments of telegraphs. February 10, 1887.

3,792. H. S. PETIT and H. S. BRESSON. Spain. An electrical fire alarum. March 12, 1887.

15,329. R. W. EDDISON. Leeds. Improvements in machines or apparatus for covering insulated electrical conductors with lead or the like (Edward McKnight, United States). November 9, 1887.

February 21, 1888.

10,680. P. EVERITT. London. Improvements in completing electric circuits. August 20, 1886.

16,109. S. F. WALKER. Cardiff. Improvements in miners' electric safety lamps. December 9, 1886.

6,853. R. W. EDDISON. Leeds. Improvements in metal-cased electric lines or cables (Tatham and Brothers and David Brooks, U.S.A.). May 10, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

3,658, 1887.—R. DICK and R. KENNEDY. Alternating current transformers. (Price 8d.)

3,767, 1887.—J. LEA. Checking the feed of an arc lamp. (Price 8d.)

4,070, 1887.—M. H. P. R. SANKEY and P. W. WILLIAMS. Combined engines and dynamos. (Price 11d.)

4,781, 1887.—THE ELECTRICAL POWER STORAGE COMPANY and H. W. BUTLER. Electric batteries. (Price 6d.)

4,809, 1887.—E. TORTORA. Insulating electrical conductors. (Price 8d.)

17,837, 1887.—P. M. JUSTICE (Acheson). Generating electricity from heat. (Price 8d.)

17,888, 1887.—G. A. SMITH. Electro-magnetic marine governors. (Price 6d.)

LEGAL INTELLIGENCE.

The Faure Electric Accumulator Company (Limited) v. Philippart.

Mr. Justice Hawkins gave judgment in this case on Monday last. He said that the Articles of Association provided that the Board should consist of not less than three directors, of whom two should be a quorum. It appeared that the Board had become reduced to two directors, of whom the defendant was one. These two held a meeting, passed a resolution to increase the Board to five members, named three gentlemen, who at once accepted the position, and the Board thereupon made the second call. It might be that the two directors had no power to reconstitute the Board, but the defendant himself was in the chair when the second call was made and when the shares were forfeited, and he was therefore estopped from disputing the validity of the call so made. In his opinion the defendant had established no legal answer to the claim for unpaid calls, but he had established an answer as to a large part of the interest claimed. There would therefore be judgment for the plaintiffs for the amount of the calls, £49,064, together with interest upon the first call from the 6th December, 1882, until the 3rd January, 1883, the date of the forfeiture, which interest amounted to £204. The judgment, therefore, would in all be for £49,268.—Judgment for the plaintiffs.

COMPANIES' MEETINGS.

The Telegraph Construction and Maintenance Company (Limited).

The twenty-fourth ordinary general meeting of this Company was held on Tuesday at the offices, 38, Old Broad-street, E.C., Sir Daniel Gooch, Bart., in the chair.

Mr. W. SHUTER (the manager) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said : I need not detain you long, gentlemen, because you have the figures before you in the shape of the accounts. I shall be very glad of course to offer any explanation with regard to these figures that you may desire. The work we have done of course represents the profits here, and it includes a considerable length of deep-sea cable. We have also effected some heavy repairs for the Anglo-American Company and the German Union Telegraph Company. You will see from the statement we have made about 8,000 miles of covered wire at the Gutta Percha Works, and I am glad to say that at those works we have been doing very much better business than hitherto. I

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mean not only cable work but general work in gutta percha, and as that is a general business, I think we may depend that that will continue (hear, hear). The difficulty is for me to make a speech, because I have really nothing to say. I cannot go into the details, of course, of our business—that would not be prudent; but I shall be very glad if there is anything in these accounts you wish to have explained to give you the explanation. I will therefore now move the resolution:—

"*That the report and accounts of the Directors to the 31st December, 1887, submitted to this meeting be and the same are hereby received and adopted, and that a dividend of £1. 16s. a share in addition to the 12s. a share interest or interim dividend paid on June 30th, 1887, be paid on all shares of the Company for the year ended 31st December, 1887, and that such dividend be paid free of income tax.*"

Mr. Philip Rawson seconded the motion.

Mr. Mackay (a shareholder) asked a few questions in explanation of certain items in the accounts, and the Chairman having replied, the resolution was put and carried unanimously.

The retiring Directors and auditors having been re-elected,

Mr. W. Shuter read the following:—The Second Bonus Trust having been closed in June last, the holders of these certificates are requested to send them in, with all outstanding coupons attached, to the Company's bankers, Messrs. Barclay, Bevan and Co., who have about £4,000 of these funds still unclaimed.

A vote of thanks to the Chairman and Directors, proposed by Mr. Mackay and seconded by Major-General Trevor, terminated the proceedings.

The India Rubber, Gutta Percha, and Telegraph Works Company.

The ordinary general meeting of this Company was held on Tuesday last, at the City Terminus Hotel, Cannon-street, Mr. S. W. Silver presiding.

The Secretary having read the notice convening the meeting,

The Chairman said: Gentlemen, you have all a copy of the report. Will you take it as read? (Taken as read.) Then it falls to my lot to move the adoption of the report. It is unnecessary for me to remark that the present state of things is very different in its results from what it has been for many years past. We have endeavoured to explain the causes in the few remarks that we have made in the report. This check to our prosperity we hope is only temporary. I must, however, remind you of the general depression that has prevailed in all branches of trade for several years past, during which time we have been able to distribute an average dividend of 15 per cent. You may depend upon it that no effort will be spared to improve our position, and I am glad to say that the prospects of doing that are encouraging. Though we have increased our returns in general manufactures, thanks to the efforts of those around us, and to additions to our agencies at home and abroad where there is a demand for our products, we have had to meet competition by contenting ourselves with a smaller profit rather than sacrifice quality. The fewness of orders for submarine cables has told doubly against the results of the year. While, on the one hand, we have not made the profit that that department has made in former years, and certain heavy fixed charges have been made which cannot be avoided, we have thereby put ourselves in an efficient state, so as to be ready to execute contracts, and these charges have been thrown upon the other branches of our business. I think it is not too much to expect that electric lighting will shortly come into general use. Now, this branch has occupied a vast amount of anxious attention in order that we may be prepared to meet the demand, however extensive, and here I may say that the works are in all respects in the highest state of efficiency. Under these circumstances, we have had no hesitation in applying some of the profit of the balance of previous years to the purpose for which it was originally intended, namely, towards the equalising of of the dividends, and therefore I beg to move—

"*That the report and accounts be received and adopted, and that a dividend of 10s. a share, free of income-tax, be paid on and after the 29th inst., making 10 per cent. for the year.*"

Mr. Neil Bannatyne seconded the motion.

Major-General Trevor wished before the motion was put to refer to the form of the auditors' certificate. He believed it was usual in commercial undertakings that had reserve funds invested for the auditor to certify to the existence and value of these securities. He would read the form of certificate which a kindred company to this, holding its annual meeting that day, adopted. The auditors there said:—"We have further inspected the several securities held by the company, and the inventories of the various stocks on hand of stores, materials, &c." Now, their auditor did not certify that he had inspected the securities at all. Perhaps it would be more satisfactory if that form of certificate were adopted in future, and when they came to the election of the auditor, he would move that it be an instruction to him to carry this suggestion into effect. The debts owing to the company were nearly £90,000. Did the directors anticipate that any of those were bad debts? He saw that the shares and debentures in other companies gave £9,000 interest, which was rather more than 5½ per cent. So far that was a very fair interest, but he begged to suggest that the nature of the companies in which more than half their reserve fund was invested should be in future stated in the balance-sheet.

Mr. Lamont asked whether there was any probability of the company receiving shortly any orders for cable work.

Mr. Leigh asked whether the 120 miles of cable referred to in the balance-sheet were in stock or in use.

The Chairman, replying to General Trevor, assured that gentleman that the auditor had duly inspected all the securities of the Company. As regarded the nature of those securities the Directors thought it well not to publish it. Mr. Lamont had asked a question that affected all of them. He (the Chairman) could only say that they lived in hopes. As regarded Mr. Leigh's question, he might say that the Company was in receipt of a fair rent for the 120 miles of cable referred to.

General Trevor repeated his question, whether the Directors had any reason to suppose that the item of debts outstanding (£90,000) included any bad debts?

The Chairman: They are all good.

The motion was then put and agreed to unanimously.

On the motion of Mr. Gray, seconded by Mr. Henderson, the retiring Directors (Mr. Silver and Mr. Bannatyne) were unanimously re-elected.

The Chairman having briefly returned thanks,

Sir Wm. Wallace moved and Captain Verey seconded the re-election of Mr. Weise, the company's auditor.

General Trevor moved that the auditor be instructed to add to his certificate, "I have also inspected the several securities held by the Company and the inventories of the various stocks on hand of stores, materials, &c."

Mr. Gray: I think it is impossible for the auditor to do it unless he takes two or three months to go into all the stock, and I question whether it is possible then. We have a very large and varied stock of material at the works. I think the number of articles on the stock list is perhaps 10,000 or 11,000, and each of these articles requires to be valued by experts who know exactly their value.

General Trevor: I meant the value of the securities.

Mr. Gray: I beg your pardon. I have nothing to say about that.

The Chairman: We are quite willing to convey your instructions, but it is effectually done.

The motion as thus amended, having been seconded, was agreed to.

Mr. Moy then moved a vote of thanks to the Chairman, which was seconded by Mr. Treble, and agreed to unanimously.

The Chairman briefly replied, and assured the meeting, on behalf of the Board, that they would always use their best endeavours to carry out the interests of the shareholders.

The Swan United Electric Light Company (Limited).

The fifth ordinary general meeting of the shareholders in this company was held at the Cannon-street Hotel last Tuesday, Mr. J. S. Forbes in the chair.

The Acting Secretary (Mr. Gover) read the notice convening the meeting, and the report and accounts were taken as read.

The Chairman, in the course of his remarks in moving the adoption of the report and accounts, said: Gentlemen, I have to apologise to you for the absence of your able secretary, Major Flood Page, who is now on his way from Berlin, where we sent him on a mission of importance. The report and accounts are short, and, I suppose, the most important and interesting part of the whole thing is to show the position of the Company as a profit-earning concern. If you will take the trouble to refer to the balance-sheet you will find how that looks, and you can do so, as the accounts, happily for you, in this kind of Company, are much less complicated than they are in some other companies with which I am connected. The essential thing in dealing with the accounts is the profit and loss statement, and if you cast your eye down the debtor side I will show you the relative state of things between the year ended the 30th September, 1887, and the year ended the 30th September, 1886. I may incidentally remark that a short time ago we made our year end on the 30th September, instead of the 30th June, for the reason that the Edison and Swan Company of Great Britain, in which you are so very largely interested, only make up their accounts to the 30th June, and when the happy moment arrives for them to distribute a dividend, you will be very large participants in that dividend which will come into the accounts subsequently submitted to you. On the 1st October, 1886, we carried into stock lamps and material of the value of £8,945. I almost think that we promised last year that we would for convenience sake put in the corresponding figures of the previous year, but the secretary does not seem to have made a note of that. The stock carried into stock in the previous year was £10,598, so, in fact, on the year we diminished the stock on hand by the difference. It is an advantage not to have too great an amount of money locked up in stock on hand. We must, however, from the nature of the business have a considerable number of lamps ready for delivery, and as we pay for them as we go on they will appear in the accounts from year to year. The accounts therefore present in that matter a difference in the stock on hand of about £1,600 less. The item of purchases figures at £6,795. That means the gross price of material necessary to produce the lamp—all the glass, the platinum, the carbon, and the many things which go to make up that very small and simple-looking instrument—the raw material. That £6,795 compares with £4,763 in the previous year. The next item I would refer to is the office expenses and wages at factories, and that amounts to £7,839, against £7,932 a year ago. Depreciation is £2,147, against £3,000 a year ago, and the balance of profit for the year is £7,554, against £4,768, so that we have upon the year advanced in respect of profit by nearly 100 per cent. Now we come to the other side of the account, and our sales (less commission and allowances) amounted to £27,128, against £22,016 in the preceding year. We do our business on a principle very well known in Birmingham and Wolverhampton. We have a standard price, and that standard price is diminished according to the number of lamps sold by a fixed discount, and that comes off our standard price. The item of transfer fees, interest, &c., is £1,665, against £1,269, and the stock carried forward into next year is £8,221, against £8,945 the year before. The office expenses, Directors' fees, rent, salaries, &c., have increased to £3,733 from

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£2,667. Well, to boil all that down, the business has progressed in a fashion which, after charging revenue very liberally with depreciation, increases the profit, as I said before, from £4,768 to £7,554, an increase of about £3,C00, which is a very substantial increase. The capital account is made up of two elements—the element of value represented in a foreign business, of which this profit and loss account is the outcrop, and the element of value made up in the large holding you have in the Edison and Swan Company. You see, by reference to the balance-sheet, that we hold in that company no less than £208,478. Now let me say a word about that company's position. Its business last year showed a profit of £16,000.

A SHAREHOLDER: Upon what capital?

The CHAIRMAN: £471,000, of which £117,000 is in deferred shares. That £16,000 would have been available for paying a dividend upon the "A" shares £85,000, and the "A" shares £267,783—upon, in fact, £350,000. That would be available but for the antecedent history of the Company, the profit and loss account having shown an accumulated loss. It was determined that before there could be any distribution of profit the loss of previous years must be paid off. Therefore that £16,000 was used in order to pay off that loss, which is now wiped off. That is what we propose to do with our balance of profit in this account. We do not propose to distribute it, because we have had to pay down the losses on the working of the concern in previous years. Those losses amounted to £10,000, an amount which has been by the process of applying profit balance from year to year reduced to £5,000 odd; and now we propose to wipe that £5,000 out, and start clear with a balance in our favour for the current year. Therefore, in both companies we have arrived at the moment when we have paid off the encumbrances resulting from losses in previous years, and we are both in the same position this year, namely, that if there be any profit to divide it will be in the discretion of the proprietors to divide it, there being no claim on it in respect of losses in previous years. Concurrently with this there is the fact that in both companies we are progressing in the sale of the article we manufacture. I suppose it is becoming pretty apparent that, notwithstanding the obstruction there is in the way of the electric light by legislation and by litigation as to patents, and by the slowness of the way such things make progress, especially in a country where gas is available at a very low rate, as in England, still it is progressing very rapidly. Every one now hears of installations being put up in theatres, clubs, public buildings, as well as in private houses, and I suppose we may assume now that they will soon spread very rapidly. The difference between the Edison Company in Great Britain, in which you are so largely interested, and the Swan Company abroad, in which you are also largely interested, is this. We have succeeded, as the result of litigation, in establishing our claim to the patents in Great Britain. We have had many fights and one test fight with Messrs. Woodhouse and Rawson of a very important character, and we have won all the appeals. We are at this moment, subject to that decision being overruled, should it ever be tested, the owners of every incandescent lamp in Great Britain. You are interested in that question, because you hold as the Swan United Company so large a stake in the Edison and Swan Company of Great Britain. Abroad, the position is not quite so settled or so advantageous. There we are in litigation, and that litigation has dragged on for a very long time, and has arrived, so far, at no conclusion. There have been decisions adverse, and decisions more or less favourable, but the matter is all *in nubibus*. We still go on manufacturing and selling the lamps, and this is the result of a year's business done under these circumstances. What was it prudent and reasonable to do? We have tried to do abroad what we have done at home with so much advantage, because I will undertake to say that if the Swan Company and the Edison Company had gone on litigating there would have been no such thing as £16,000 last year for the Edison and Swan Company, nor in any year in which such litigation had continued. By putting the horses together we made the Company strong in unity of interests and strong against the rascality of infringers. I was in hopes to-day that we might have been able to announce some sort of treaty or agreement with the foreign companies bringing into life that desirable result, but we cannot do so. We have had in Paris communication with the French Edison Company, who are contesting with us in France the right to make and sell lamps, and in Belgium, Austria, and Russia, and we have come to something like the basis of an arrangement with those gentlemen, under which it is proposed we should become partners in the lamp business just as the Edison and Swan Companies in London became partners in the lamp business—that is, we put all our assets into one pot and divide our profits by agreed proportions. The parties are agreed on that, but unfortunately the Edison people seem to have made some loose arrangement, and the power of the French Company is somewhat interfered with by the application of those agreements. One of the principal litigations is going on in Germany. We hear of the delay of the law in England, and grumble at it. If it is any consolation for you to know it, I may mention that in Germany the delay is something still more awful. There patent cases have been on for three years, and I suppose I can say they seem as far off a decision as ever. We were very anxious to get off this German litigation, as Germany is not far from France, and it is a pretty long frontier. That was one reason for making them partners if we could, so as to have some sort of universal agreement. Major Flood Page is on his way back from Berlin to tell us the result of his interviews with the parties who pull the strings. He went there with the full concurrence of the French Company, and what he is coming back to tell us I cannot say, but from my knowledge of the Germans I believe that they will not at once come into the matter, though probably they will after a little time. If we do succeed in putting the things together I have no hesitation in predicting that it will be very profitable. It all comes to this—is this position satisfactory as against the position that was? I think I have tried to explain it. You are making profits. The profits you have made have paid off your losses, and you start afresh with a considerable amount of profit in hand. You do not owe anything; in regard to the British business your patents have been established, I suppose, beyond all reversal, and the business will increase very rapidly. I think those facts justify the prediction that our Company is in a sound position, and one from which shareholders will reasonably soon reap the benefits which they went in for, and certainly which their patience deserves. In regard to the capital account, there is nothing on the debtor side. The share capital remains the same as before, and amounts to £375,C00. This item, in fact, has really slightly diminished, because the corresponding entry of 1886 was £377,983, and that is explained by the item of forfeited shares, £3,530 against £365 in the previous year. That accounts at once for the diminution. Sundry credit balances is an item amounting to £4,055. Then there is the special reserve against depreciation of plant, £3,000. That is a sum which we took the liberty of taking out of the profit of the preceding year, amounting to £4,768. We thought it better to be secured against contingencies. I explained the matter fully at the last meeting, and we put to reserve out of profit £3,000 in order to meet any contingencies. As I said before, that brings us down to a debit balance on the 30th September, 1886, of £5,834. On the other side of the account you see the old story—the cost of patent rights as put in last year's balance-sheet. I have said before that when people consented to pay so large a sum for patent rights they were simply mad, and our friend, Mr. Swan, was happy in participating, to his very great advantage and that of his friends, in the madness of his fellow creatures. He is a happy inventor, because Mr. Edison is equally eminent, and has not got the solid pudding Mr. Swan has got. It seems a very large sum of money to pay for a patent right, and the cost of the patents would have been much more palatable if ours had been a patent; but, then, we had to spend a large sum of money in order to establish it. Everyone at the outset thought he had got a gold mine in electric lighting. I am not blaming anybody who negotiated the agreement. I am only telling you what the hard facts are. We, however, have got a patent now, and we have it for six years, and during that period we have got the opportunity, if we are as wise and prudent as ordinary tradesmen are, and conduct our business on the lines of ordinary tradesmen, to improve our commodity, and to extend our connections, so that when we emerge from the protection of the patent we shall have established a reputation and obtained a large connection, and a trade mark which will enable us to compete with all comers. Therefore, I am not sure that the cost of patent rights, £105,000, is a very heavy sum to pay. Anyhow, there it is. We have spent in a variety of ways £3,330 during the year, in addition to the £105,000, but we have deducted from that sum 20 per cent. for depreciation, and I think that that is a very liberal scale of reduction, and if it is an error it is in being too much and not too little. Sundry debtors amount to £10,160, of which, I think, about £9,000 were in good book debts at the end of the year. Stock in hand I have explained. From the nature of our business we must keep in stock a very large number of lamps, and those lamps are estimated not at their selling price, but at their cost price in the accounts as an asset, and they represent what in fact are called efficient lamps—lamps ready for sale or order. We merely credit the account with cost price. We then come to our solid pudding—what we have held our grip on out of the subscriptions of the shareholders—on the other side of the account. We have an investment in Prussian Consols amounting to £13,116. We are obliged, being a foreign company trading in Germany, to invest some money in Prussian Consols, and we need only have invested £5,000, but we found, having to do it, that the investment was a desirable one, and we put a portion of our eggs in that basket. Then there is loan on mortgage, £14,300. We lent our partners, the Edison and Swan Company, that sum on a mortgage on the new and beautiful factory at Ponder's End where their business is carried on. That amount, by the way, has since been paid off. Then we have an investment in Consols of about £2,000, and our cash on deposit and in hand amounts to £16,669. I say we have, but I mean we had at the date of the accounts. Therefore you see that you should have a very large amount of money, or assets as good as money, in hand. I think I have exhausted the accounts now; but I want to emphasise this—that but for the unfortunate fact that we had got on our backs the debts of our youth (and as prudent people we could not go on without working them off) we should have had a balance of profit to deal with, but we have applied that balance to writing off those debts once and for all. That will enable us to carry forward into next account a small balance for the benefit of the current year. Having explained all that as fully as I can, and being ready to answer any interrogatories, I now move the adoption of the report and accounts for the year ended 30th September, 1887.

The DEPUTY-CHAIRMAN (Mr. F. R. Leyland): I beg to second that. I wish to express my own strong conviction of the desirability, if we can, of making some reasonable arrangement with our competitors on the Continent, something on the same lines as we have made in this country, and I believe it will be to the interests of the shareholders if that matter is left—at all events for the present—in the hands of the Board to continue the necessary negotiations in the hope that they will bring them to such a point that they will feel justified in placing the matter before the shareholders at some subsequent meeting for their approval and their sanction. If this is arrived at I think we may sincerely say that we shall owe it chiefly to the great trouble which the Chairman has taken in conducting these negotiations, not only in London, but also in Paris, and if they are brought to a successful issue, as I hope they may be, I think we shall have something pleasant to say on that point.

A SHAREHOLDER inquired how long Mr. Swan's salary was to continue.

The CHAIRMAN replied that it was part of the agreement it was to continue for seven years. They bought not only Mr. Swan's patents for what they were worth at the moment, but Mr. Swan's brains for a term of years. That agreement had to run for two years longer. Mr. Swan gave them the benefit of his extraordinary inventive genius, and was always at their call.

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A SHAREHOLDER asked what interest was received by the Company on the mortgage.

The CHAIRMAN: Four per cent., but the mortgage has been paid off.

Mr. JOHN VERITY thought it must be a source of satisfaction to the shareholders to see that the Company had got through its difficulties. At the time of the amalgamation there were a great many outstanding negotiations and a great many questions unsettled, and having overcome their difficulties, wiped off their losses, and having a small balance in hand to carry forward to the credit of the current year, he thought the Directors ought to receive the thanks of the shareholders. He believed that when they met next year they would have a far more satisfactory state of things to consider. Large central stations were being started in England as well as abroad, and large central stations required a great many lamps. It must also be very satisfactory to them to see that at last they had got rid of all the law suits. He believed that the Swan lamp was very much preferred abroad; but he thought that the Edison interests were very serious rivals to them, and that they ought to amalgamate the interests of the Edison and Swan people abroad. If that were done he believed there would be a much greater chance of an amalgamation being pulled through with the Germans. In regard to Mr. Swan's salary, a contract was a contract, and if they had to pay that gentleman a certain sum annually they must do so; but he thought that Mr. Swan might meet them a little in the matter of his salary, seeing that he had received such a large sum for his patents. He would also like to know if Mr. Swan had been giving his attention to the improving of the efficiency of the incandescent lamp. He noticed that Mr. Leyland was down for re-election as one of the retiring directors, and he did not think there were many present who knew what a large debt they owed that gentleman. He made that remark with all deference to Mr. Forbes, who, he was sure, would agree with it.

Mr. REYNOLDS said he could not agree with the last speaker with regard to Mr. Swan's salary. For his own part he thought that £400 a year paid to that gentleman was a very small sum, and he could only say that if Mr. Swan would join his (the speaker's) firm and transfer his experience to them they would very gladly give him three times as much. He had been glad to hear the remark of Mr. Leyland that he was anxious to see an end put to foreign competition. He had been surprised to hear nothing whatever said with reference to the litigation pending with the Anglo-American Brush Company. The chairman had referred to infringers. If he (the speaker) were rightly informed, the infringement now to be considered was with reference to the Lane-Fox patent, and the infringement the Brush Company contested was on the part of the Company. He would be very glad to hear from the Chairman that they were prepared to do something with the Brush Company in reference to the difficulties that had arisen. The Chairman had stated that the Company's patent would only run for six years, and he (the speaker) noticed that nothing had been written off the value of the patents in the balance-sheet.

Mr. K. HEDGES said he could assure the last speaker that the Swan lamp was the most efficient, and that no one used the Edison lamp who could use the Swan. He thought the Company were to be congratulated on the progress which they had made, and before next year he thought they would be in an extremely satisfactory state, because the number of lamps that would be required for stations would be enormous. The company that used to be the Grosvenor Gallery Company was starting a central station at Deptford, and there were three other companies doing the same thing. He himself was going through the details of another factory where 50,000 lamps would be required, and that brought up the number required for these central stations to a quarter of a million.

The CHAIRMAN, in reply, said he was very glad indeed that a discussion had taken place, because they had had the opinion of three gentlemen eminently well qualified to advise them. In regard to the remarks of Mr. Reynolds, he would only say that after immense litigation the Company had got their patents protected, and they were willing and determined to rest on those decisions. It was competent for the public to call on the Company to supply either Swan or Edison lamps, and they did, in fact, for a time supply those lamps at discretion. They could get the lamps from Mr. Edison on terms rather less advantageous to them as a matter of profit and loss than their own lamps, but they could supply the Edison lamps. When the public had the opportunity of getting a Swan or Edison lamp it was a pretty good test of the relative value of the two that the demand for the Edison lamp had died out, the whole demand being for the Swan lamp. That was a pretty good illustration as to what was considered the best lamp, and that they found was rather an important factor in the negotiations abroad, because the men who were fighting for their own hands said that one of the chief inducements they had for coming to an arrangement was the superiority of the Swan lamp. In virtue of that they were prepared to make concessions which at first they would not listen to. He had had the opportunity of listening to all that Mr. Sellon could say on the position of the Brush Company, and all that Lord Thurlow could say, but they had not been able to agree to the views of those gentlemen. Everything they had said about their case had been said by Messrs. Woodhouse and Rawson and other infringers, and when he used the word "rascally" infringers in his opening speech he did not mean honourable gentlemen who imagined they had a patent but had not—he meant piratical infringers who had no patent. He had contended both with Lord Thurlow and Mr. Sellon that the Brush Company had nothing to sell. The company must rest on their patents and on the protection which those patents had given them. If Lord Thurlow were to persuade the directors to throw away some of the interests of the company there would be plenty of others who would endeavour to obtain the same concession. The litigation was going on, and he would ask Mr. Crisp to explain how it stood.

Mr. CRISP said that the general position of the litigation with the Brush Company was this: they were proceeding against that company on precisely the same lines as they had proceeded against Messrs. Woodhouse and Rawson. In that action exactly the same issues were raised. No new fact had been brought forward by the Brush Company which had not been fully thrashed out in the action with Messrs. Woodhouse and Rawson. There was a second action brought against them by the Brush Company as to their lamp, over which they had a great deal of anxiety to discover what possible ground there was for bringing the action. One of the actions was expected to be settled in a month, and the other next week.

A SHAREHOLDER said he observed that the Company held Edison and Swan shares to the amount of £208,478. He assumed that that was the nominal value, but could the Chairman give the shareholders any idea of the market value?

The CHAIRMAN said that he was not himself in the habit of watching the market. He should think that the proper value of the shares was the amount at which they stood in the assets. He did not always find the Stock Exchange value of a thing was its proper value.

He then put the motion, and declared it carried unanimously. Continuing, he proposed the re-election of Mr. Leyland, remarking that, as Mr. Verity had said, the Company owed a very great debt of gratitude to Mr. Leyland, who had pulled the leading oar in their boat.

Mr. QUILTER, M.P., in seconding the motion, also testified to the valuable services which Mr. Leyland had rendered to the Company. Any success which the Company had had had been very largely contributed to by Mr. Leyland. With regard to the question which had been asked as to the value of the £208,478, which they held in the shares of the Edison and Swan Company, he could not give any detailed information on the subject, for the reason that the shares were not quoted in the official list, and he was not aware of any transactions having taking place in those shares on the London Stock Exchange. Whatever might be the present value of the shares, he thought that, in view of what the Chairman had said, it was obvious there must be a large increase in their value should they ever be quoted.

The CHAIRMAN having put the motion, which was carried unanimously, moved the re-election as a Director of Mr. Quilter.

Viscount ANSON seconded the motion.

Mr. SWAN said he would like to make a few remarks in reference to the observations which had been made by Mr. Verity. That gentleman had spoken under the impression that he (Mr. Swan) had practically disconnected himself altogether from the progress of electric light invention, and more particularly from the lamp. That, however, was an entire mistake. He was continually working one way or another upon matters which he believed would be beneficial to the Company, and so far as his lamp was concerned, he had done very much he thought to help forward its improvement. Quite recently the Company took out a patent which he believed would be of value in connection with the improvement in the incandescent lamp. He was always working one way or another for the benefit of the Company, and he was always at their service. There was one point which he thought ought to be remembered by those who might be inclined rather to grudge the small payment which was made to him, and that was that when the undertaking was first formed he did not offer his services to the Company. They were sought, and it would have been very much more in accordance with his own wishes if he had been left entirely free, and had not been solicited to occupy the position of a Director of the Company. If he had done so he was sure it would have been very greatly to his pecuniary advantage, for the consequence of his joining the Board of the Company was that he had to leave a lucrative business in Newcastle.

On the motion of Mr. HARVEY, seconded by Mr. BEAUMONT, Messrs. Quilter, Welton and Co. were re-elected auditors.

Mr. VERITY then proposed, and Mr. REYNOLDS seconded, a vote of thanks to the Chairman and Directors.

The CHAIRMAN, in reply, expressed his acknowledgments, and said he was sure that the compliment which had been paid them was appreciated by his colleagues as much as by himself.

The proceedings then terminated.

The Telephone Company of Egypt (Limited).

Report of the Directors for the year ended 31st December, 1887, to be presented at the fifth ordinary general meeting of the Company, to be held at the offices of the Company, 14, Austin Friars, on Tuesday, the 6th March, at 12 noon.

The amount of revenue accrued for the past year exceeds that of the previous year by £498. 18s. 10d.; the working expenses have, however, been heavier, due to a large extent to reconstruction of some of the lines, the cost of which has been charged against revenue.

After writing off a sum of £219. 9s. 5d. for depreciation, the net profit for the year is £3,844. 0s. 4d., and including £442. 8s. 2d. brought forward from the previous year, there is available for distribution £4,286. 8s. 6d. Out of this the Directors propose to pay a dividend of 6 per cent. for the year on the preferred shares, which will absorb £3,621. 6s., and to carry forward £665. 2s. 6d.

The dividend now proposed will be applied in payment of the arrears of cumulated interest to 31st December, 1885, which will thus be finally discharged, and dividends hereafter declared will belong to the years for which the accounts are rendered.

The past year has been marked by the opening of two small exchanges at Zagazig and Mansourah, and the Directors believe that there is room for still further development in this direction.

Permission has lately been granted by the Government for an extension of the system to Hélouan, and a trunk wire connecting Cairo with that place—distant some 16 miles—is now in course of erection. A royalty will be payable to the Government on the gross revenue of this branch in consideration of the permission accorded.

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The Directors deeply regret to have to record the death, after a very short illness, of Mr. A. D. Evans, the Company's late manager in Egypt, which took place at Brighton on the 15th October last. The success which has characterised the operations of the Company in Egypt has been largely due to the assiduity with which Mr. Evans conducted the business.

The following figures show the progress made by the Company since its formation:—

	On 31st December				
	1883.	1884.	1885.	1886.	1887.
Total number of subscribers in Egypt	454	547	714	817	917
Gross revenue	£6,400	£7,014	£8,650	£9,400	£10,000

In order to liquidate the loan from the Oriental Telephone Company (Limited), and to provide for working capital, the Directors propose to create 6 per cent. debentures to the extent of £20,000, and to issue £10,000 thereof. In terms of the Articles of Association, a resolution to that effect will be submitted for your approval.

The Director who retires on the present occasion is Mr. H. Grëwing, who being eligible, offers himself for re-election. Messrs. Price, Waterhouse and Co., the auditors of the Company, also retire, and offer themselves for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts for the week ended 24th February amounted to the sum of £4,643.

LANCASHIRE AND CHESHIRE TELEPHONIC EXCHANGE COMPANY.—The directors have declared an interim dividend at the rate of 7 per cent. per annum, being the same as last year.

WEST AFRICAN TELEGRAPH COMPANY.—The half-year's interest due 1st inst. upon the Five per Cent. Debentures of this company will be paid at the National Bank of Scotland, Nicholas-lane, on and after that date.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this company for the week ended February 24th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,750.

NEW COMPANIES REGISTERED.

THE BOURNEMOUTH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—Registered by Peacock and Goddard, 3, South-square, Gray's Inn, under Table A. Capital £4,000, divided into 800 shares of £5 each. Object, to supply approved renters in the town of Bournemouth and its neighbourhood with electric light and power, and to carry on the business of an electric light and power company in all its branches. The first subscribers are:—

	Shares.
F. J. Bright, bookseller and stationer, The Arcade, Bournemouth	1
J. Denkin, architect, Bournemouth	1
J. J. Allen, house furnisher, The Quadrant, Bournemouth	1
H. Hammond, draper, Bournemouth	1
P. W. G. Nunn, physician and surgeon, Bournemouth	1
C. P. Fippard, cook and confectioner, Bournemouth	1
J. S. Helyer, architect and estate agent, Bournemouth	1

GULCHER (NEW) ELECTRIC LIGHT AND POWER COMPANY.—This company is formed for the purchase of the goodwill, patents, plants, materials, stock-in-trade, contracts, and other property of the Gülcher Electric Light and Power Company (Limited). The capital is £70,000 in 70,000 shares of £1 each, of which 50,000 are 10 per cent. preference shares, and 20,000 are deferred shares. The business is acquired in consideration of a payment of £16,000 and 20,000 deferred shares to the liquidator of the old company. The present issue is of 25,000 preference shares.

NOTTING HILL ELECTRIC LIGHTING COMPANY (LIMITED)—Registered by Loughborough and Gedge, 20, Great Winchester-street, E.C., with a capital of £100,000 in £10 shares. Object, to light public or private buildings, places, or property with electric light, and to undertake the supply and application of electricity or force generated or produced by or by the aid of electricity, for any public or private purpose. The first subscribers are:—

	Shares.
S. Waters, 24, Ladbroke-square, W.	1
J. T. Jarvis, 30, Ladbroke-square, W.	1
W. Crookes, 7, Kensington-park-gardens, W.	1
J. Crookes, 7, Kensington-park-gardens, W.	1
A. Howden, 72, Holland-park, W.	1
F. Radford, 26, Pembridge-gardens, W.	1
A. Webb, 13, Lansdowne-crescent, W.	1

The number of directors shall not be more than ten nor less than three, and the first shall be William Crookes, Aston Webb, Francis Radford, Alexander Howden, James Thomas Jarvis and Sidney Waters.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Feb. 29, 1888.	Rate per cent. Yielded. £. s. d.	Dividend Due.	Business Done during Week Ending Feb. 29, 1888. Highest.	Lowest.
£			**TELEGRAPHS.**					
1,770,360	Stock	10/0	Anglo-American	40½ 41½	3 6 3	Jan., Apr., July, Oct.	41½	40
2,614,820	Stock	20/0	Do. Preferred	66½ 67½	4 1 8	,, ,,	67¾	66
2,614,820	Stock	nil.	Do. Deferred	14 15	...	February	15	14½
130,000	£10	3/0	Brazilian Submarine	11¾ 12	5 16 8	Mar., June, Oct., Dec.	11⅞	...
16,000	10	8/0	Cuba Submarine	12¼ 12¾	6 6 0	February and August	...	...
6,000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	...	...
			Direct Spanish	3¼ 3¾	...	...	3½	...
6,000	5	5/0	Do. Preference	8½ 9½	...	April and October ...	...	...
60,710	20	2/0	Direct United States	8⅞ 9⅛	4 8 0	Jan., Apr., July, Oct.	9 1/16	8⅞
380,000	10	2/6	Eastern	11¼ 11½	4 16 9	,, ,,	11⅜	11¼
70,000	10	3/0	Do. 6 per Cent. Preference	14¼ 14¾	4 1 4	,, ,,	14⅜	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 0 0	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅛ 12⅝	4 17 6	Jan., Apr., July, Oct	12 5/16	12¼
22,050	10	5/9	German Union Telegraph and Trust	8¾ 9¼	6 9 9	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅜ 5⅞	4 18 0	Jan., Apr., July, Oct.	5 13/16	5⅝
178,992	10	3/0	Do. 6 per Cent. Preference	13⅜ 13⅝	4 8 0	,, ,,	13 9/16	13¼
150,000	10	5%	Great Northern	13¾ 14¼	5 5 6	Jan., July, and April	14¼	14⅛
17,000	25	5/0	Indo-European	38 40	6 5 0	April and October ...	...	...
			London Platino Brazilian	5 5½	...	...	5 5/16	5 1/16
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October ...	...	...
338,225	Stock	12%	Submarine	135 145	9 9 0	February & August	...	...
30,000	10	6/0	West Coast of America	5¼ 5¾	8 13 9	January and July ...	...	...
			Do. Debentures	111 116	...	...	...	...
88,321	10	nil.	West India and Panama	⅝ ⅞	...	...	¾	...
34,563	10	9/0	Do. 1st Preference	9½ 10	7 10 0	April and October ...	10	9 13/16
45,181	15	3/9	Western Brazilian	9¼ 9½	8 12 9	March & September	9½	9 3/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 104	5 15 5	March & September	102	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	9/16 1⅛	5 9 0	Yearly	...	...
			Oriental	¼ ½	...	...	...	...
80,000	£5	5/0	United	13 13½	4 16 3	June and December	13 7/16	13⅛
			United River Plate	4¾ 5¼	...	...	4 11/16	...
			ELECTRIC LIGHT.					
	5		Anglo-American Brush (£4 paid)	3 3½	...	...	3	2⅞
23,692	5	nil.	Do. (fully paid)	4 4½	...	February & August	4½	3⅞
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2½	...	...	2½	2¼
312,000	¼	0/1½d. '86	Maxim-Weston	⅛ ¼	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance xd	37 39	6 1 3	March and July	40	38¼
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works xd	15 17	5 17 8	February & August	16½	15¾

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

It is sometimes said that figures can be made to prove anything; but it would be a difficult task to manipulate the figures presented last night by Mr. Treuenfeld so as to *disprove* the conclusion that an enormous amount of property has been preserved from destruction by the system of fire telegraphs, and also that every year a vast amount is still lost which might be saved by an adequate provision of these safeguards. It is simply astounding to learn that there are at the present time only seven towns in this country that have adopted the system of street fire-alarm posts. The results of this negligence—for by no other term can it be described—are shown in the most decisive way by the statistics brought forward by Mr. Treuenfeld. To quote only one example, in Hull, where there are no street fire-alarms, during the period 1881-1886, the percentage of "serious" fires to total calls was as high as 64·1; while in Glasgow, where Anderson and Munro's street fire-alarms were adopted in 1879, the ratio of "serious" to total fires since that date has averaged 1·1 per cent. Of course there are many other things to be taken into consideration in contrasting Glasgow with Hull, but it is impossible to overlook the absence of a proper system of alarms. The subject is one of the highest possible importance to the community at large, and it is difficult to understand in what way the local authorities can better expend their revenues than in the provision of this inexpensive and effective means of insurance. A copy of Mr. Treuenfeld's paper will, we hope, be sent to every important municipality throughout the kingdom; if this be done, we have little doubt that it will result in a large extension of fire telegraphs, and a corresponding diminution in the loss of life and property from fire.

We give this week the first portion of Capt. C. E. M'Evoy's description of electrical appliances for submarine mining to which we referred in our last issue. The extreme ingenuity and skill with which the details have been worked out can scarcely be fully appreciated without a personal examination of the apparatus. Two problems of equal importance have to be solved in these cases; first, to ensure that the mines shall not be exploded prematurely or unintentionally, and, secondly, that they shall infallibly explode when required. So far as human skill can provide, each of these essentials is fully attained by Capt. M'Evoy's apparatus. When the firing position is arrived at, and before the insertion of the firing plug can bring about the final result, both eye and ear are appealed to in such a way as to render a mishap due to carelessness almost absolutely impossible.

We are glad to see that the *Army and Navy Gazette* has this week an article on "Submarine Miners," following up much the same line as was adopted by ourselves four months ago. The necessity for the creation of additional volunteer corps for the protection of the mercantile ports is fully recognised. It is of course assumed that the rank and file should consist chiefly of sailors or naval reserve men, but the assistance of technical officers is admittedly indispensable.

In our continuation of the report of the recent discussion at the Society of Telegraph-Engineers will be found a diagram of the interesting experiment recently carried out by Mr. Mordey in order to get a visible indication of the difference of phase between the primary and secondary currents of a transformer. This has suggested to us the possibility of "seeing" the lag due to self-induction in a somewhat more direct manner. The experiment would only be useful for lecture purposes, as it could not be made with a closed magnetic circuit transformer, and we give it merely for what it may happen to be worth. It is well known that if the vibrating make-and-break of an ordinary induction coil is looked at by the light of a Geissler tube, placed in the secondary circuit of the same coil, the vibrator appears, for obvious reasons, to be absolutely at rest. But the moment of illumination of the tube may be retarded in reference to the phase of the vibrator by varying the amount of inductance in the external circuit of the coil. Consequently, by placing an inductional resistance in series with the tube, it may be expected that the apparent position of the vibrator will change. If the external resistance takes the form of a solenoid with a movable iron core, then, on moving the core slowly to and fro, we should expect to see the vibrator apparently moving in unison therewith. It would be easy, if necessary, to arrange a mechanical device to exaggerate the apparent motion of the vibrator. We hope that the simplicity of the experiment will induce some of our readers to try it.

From a paper which we publish in this issue it will be seen that Dr. Fleming has determined the specific resistance of manganese steel, and finds it to be 3¼ times as great as that of German silver. Next week we shall give some determinations (by Mr. Mordey) of the specific resistances of several

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new alloys. Amongst these occurs a certain alloy of copper which has a resistance very nearly equal to that of manganese steel, with a much lower temperature coefficient.

WITH regard to the utilisation of wind power for electric lighting we may mention that Sir DAVID SALOMONS, some years ago, planned an installation of this character for 150 lamps, or 300 with accumulators, and he has kindly furnished us with the estimate which he obtained. It will, however, be remarked that the number of lamps proposed was somewhat large for an installation of this class. A set of windmill gearing, including 65ft. iron support, shafting, and governor, to indicate 15 horse-power with a 20-mile wind within 10 per cent. of regularity (and nothing better can be done by the best governors made), would cost £1,160. The foundations would have cost quite £150 more. For dynamo and gearing, including a special governor to compensate the 10 per cent. speed variation, another £250 might be added—total £1,560, or over £10 per lamp, without accumulators. We believe, however, that the Glasgow installation, to which we recently alluded, does not comprise more than 10 or 12 lamps.

ALTHOUGH the recent "Convention" of the American Edison Companies at Chicago was held with closed doors, our New York correspondent was enabled in our last issue to give some very interesting details of the proceedings. From this it will be seen that an important move is likely to be made in raising the standard voltage of the Edison system from 220 to 330 volts. Whether this is to be effected by an advance from a three-wire to a four-wire network, or by the substitution of 165-volt lamps for the present 110-volt type, we are not told, though the former is perhaps more probable. The fact that Edison, overcoming his "almost invincible repugnance" to appear in public, addressed the meeting in person, is evidence of the importance attached to the occasion.

ON this point we are enabled to add some further information derived from an independent and thoroughly authentic source. It appears that about twelve months ago several important local companies working the Edison system in America found that they had practically arrived at the end of their tether—that is to say, they had completely covered the ground within the limits of the three-wire 220-volt system, and, unless they could extend the economical radius of distribution, the output could not be further increased. Whether or not they had in all cases arrived at the limit of 20,000 lamps, which Mr. GORDON holds to represent the maximum economical output for a single station, we cannot say, though a maximum current of 9,000 amperes mentioned by our correspondent represents about 36,000 lamps, and might mean nearly 50,000 wired. However this may be, it appears that under the aforesaid circumstances a strong disposition was shown to introduce alternating currents for the supply of the outer circle, and a memorial was presented to the parent company in favour of such a step. But although the movement was strongly supported by several of the leading men connected with the system, Edison himself set his face against it from the first. We may believe that it was this agitation which recently led Edison to rake up his earlier patents with motor-generators, and to lay down the experimental plant of this type, which is now running at Llewellyn Park (see *The Electrician*, October 14th, 1887). We have yet to learn how much success the latter system has attained, but it is tolerably evident that it has not yet emerged from the experimental stage. It is also evident from our correspondent's letter that Edison has succeeded in stemming the movement which had set in amongst his supporters in favour of alternating currents. Probably the enormous increase of business from the transmission of motive power had also a good deal to do with the decision to stand by the continuous current.

IN the light of these and other facts it is, however, not a little singular to find that Mr. CROMPTON, in this country, is perfectly content to abide by a simple parallel distribution. On this point we find that some misunderstanding exists as to the nature of the installation at Kensington Court. We may therefore state that—unlike Mr. CROMPTON'S Vienna installation—the batteries used at Kensington Court are confined to the generating station, and the distribution in the mains is entirely at low tension. The batteries are employed solely in order to enable the machines to work for a shorter period, and not, as in the B.T.K. system, to increase the efficiency of the distributing mains. It will therefore be seen that Mr. CROMPTON'S advocacy of the continuous current is of a remarkably uncompromising—in view of the rise in copper we might almost say of an heroic—character; and although we expressed last week our concurrence with much that Mr. CROMPTON urged in his recent speech at the Society of Telegraph-Engineers, we have yet to be convinced that it is wise to relinquish the advantages offered by multiple main distribution.

THE most satisfactory feature in the report of the Anglo-American Brush Corporation (whose annual meeting is reported in another column) is undoubtedly to be found in the evidence which it affords of the large increase in the volume of business transacted during the last twelve months. This is only a confirmation of the general impression that a genuine revival of electric lighting business has set in. The corporation has done well to recognise the desirability of enlarging its field of operations by the adoption of alternating-current plant. And we think that the expressions of satisfaction made use of by the Chairman in speaking of the transformer and the alternating-current dynamo designed by Mr. MORDEY will be found to be fully justified by the issue. The Mordey transformer is already familiar to our readers from the recent proceedings of the Society of Telegraph-Engineers. The dynamo, which we hope shortly to describe and illustrate, will be found to embody a decidedly novel departure in the construction of alternating-current machines.

MONDAY night's discussion of the Electric Light Amendment Bill in the House of Lords revealed not merely a fairer appreciation of the merits of the Bill, but a more candid esti-

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mate of the demerits of local authorities. There could be no mistake about Lord SALISBURY'S remarks on the danger of creating irresponsible corporate bodies on the pretence of placing them under the control of local authorities. The experiment has not proved wholly satisfactory, the gas and water boards being chiefly notable for their independence and extravagance. It may be anticipated, however, that long before the 42 years' life of a provisional order has run out the local authorities will be better fitted than they are at present to take over the business of electric lighting.

THE POSTMASTER-GENERAL'S declaration with regard to the purchase of the telephone companies by the Government conveys precisely what we have asserted all along, namely, the fact that no such project has been under consideration, or is even contemplated. Many persons will be aggrieved by this answer, but they cannot charge it with indefiniteness. It is much to be regretted, however, that it was not made earlier.

WE have been favoured with a communication from Mr. GEORGE QUARRIE, who writes: "As other prints will probably refer to the following matter, I give you a like opportunity, merely adding that you are at perfect liberty to treat the same as you please." Of course we feel very grateful, and will proceed to avail ourselves of the liberty which is so kindly accorded us. Mr. QUARRIE is not altogether unknown to fame, if indeed he is the gentleman of the same name who once proposed to provide electricity *ad lib.* by laying down an iron floor upon the roadway and utilising the vibration of the passing traffic by means of suitable electro magnets. It appears, however, that Mr. QUARRIE has now turned his attention from practice to theory, and in the communication before us he offers a reply to the ever interesting question "What is Electricity?" "Electricity," says Mr. QUARRIE, is "Nature's vacuum." This seems simple enough at first sight, though we are a little puzzled at reading further on that "All matter is visible and tangible only by virtue of the electricity it contains." A visible and tangible vacuum is a conception by no means without a certain degree of merit. At the end of the paper we learn that Mr. QUARRIE anticipates that his discovery will lead to "a means of providing cheaper current electricity." But on the whole we think the iron roadway scheme the more hopeful of the two.

UP to the time of going to press our New York correspondent's letter had not come to hand. The principal electrical news from America—apart from the Pittsburg Convention, which we deal with elsewhere—appears to be the announcement that Edison is about to bring out a new type of incandescent lamp, having a standard consumption of 3·1 watts per candle-power. The 16-candle power lamps will range from 90 to 125 volts. This is for use in isolated plants. For central station lighting a 150-volt lamp, with specially long filament, has been designed. The filament makes three distinct spiral twists. For use with secondary batteries, lamps of 60, 40, and 20 volts, running at 2½ watts per candle-power, and giving from 10 to 30 candles, are promised shortly.

Weston-super-Mare.—The Town Commissioners have finally decided to postpone the question of lighting the town by electricity for the present.

Taunton.—At a meeting of the Lighting Committee of the Town Council of Taunton it was unanimously decided to recommend the Council to provide thirty additional arc lamps for public lighting of the streets.

Electric Communication in the House of Commons.—It is proposed to establish electric communication between the Library and the House, so that members in the Library may know who is addressing the House.

Dumbarton.—The extensive ship-building yards of Messrs. William Denny and Brothers, at Dumbarton, are to be lit throughout by electric light. Inquiries are now being made amongst the leading electrical firms.

Vienna.—A new patent law is under the consideration of the Government.—The Electrotechnical Institute of Vienna is carrying out a series of tests of accumulators. The Julien, Reckenzaun, and Scheneck-Farbaki types are under consideration.

Cheltenham.—An installation of one arc and sixty incandescent lamps has been fitted up for a tradesman in one of the chief streets of Cheltenham by the Walsall Electrical Company. A Crossley 4 horse-power nominal gas engine and a set of storage cells are employed.

A New Scientific Society.—It is announced that a new scientific society has been formed in Paris, to be called the Société Magnétique de France. The *Journal du Magnétisme* is to become the official organ of the new society, and its offices are at 5, Boulevard du Temple, Paris.

Royal Institution.—At the general monthly meeting of the Royal Institution, held on Monday, March 5th, Edward Woods, Esq., M.Inst.C.E., Vice-President, in the chair, the special thanks of the members were returned to Prof. Dewar for a donation of £100 to the fund for the Promotion of Experimental Research.

The Electric Lighting of Terni, Italy.—The lighting of this town by electricity was commenced on the 12th ult. The motive power is furnished by three turbines of 160 horse-power each, made by Ganz of Buda-Pesth. Each turbine drives a Zipernowski dynamo. The total number of incandescent lamps is 300.

Electrical Organ at the Barcelona Exhibition.—The local paper, *El Barcelonés*, of March 2, states that the Palace of Fine Arts at the Barcelona Exhibition is to be furnished with an electrical organ constructed by Dr. Aquilino Amezua. It is stated that the organ will be in three distinct parts, each communicating with the key board by electric wires.

Glasgow.—The *Glasgow Herald* understands that steps were taken last week in Glasgow to form a company for the manufacture and sale of electric current there on the same lines as those in London. As Glasgow is a city of fewer burning hours than London, it is proposed to utilise the spare time of the plant there for driving machinery during the day.

The Italian Exhibition and the Electric Light.—According to advices from Rome, the coming Italian Exhibition which is to be opened at Earl's Court in May next is to be lighted by the electric light by an Italian firm. The *Bollettino delle Finanze, Ferrovie e Industrie* of March 4th says that the undertaking has been confided to Messrs. A. Belloni and Co., of Milan.

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Madrid.—The *Avenir Financier* states that at an extraordinary meeting of the Telephone Company of Madrid, it was decided to increase the capital from 1,200,000fr. to 1,800,000fr. by the creation of 1,200 shares of 500fr. each, upon which 250fr. is to be paid up. This increase of capital from £48,000 to £72,000 is said to be rendered necessary by the expansion of the company's business.

Electric Lighting of the ss. "Oonah."—On Tuesday the electric light was put into operation in the fine new screw steamer "Oonah," built to the order of the Tasmanian Steam Navigation Company by Messrs. A. and J. Inglis, of Pointhouse, and constructed under the superintendence of Mr. H. R. Robson, the company's agent in this country. There are in all 165 lights, representing an installation of 2,460 candle-power.

The United States Telegraphs.—A Washington telegram says that the Post Office Committee of the Senate has decided to report the Bill for regulating the Inter-State telegraph system on a plan similar to that which obtains with regard to the railway system. The Bill contains a clause prohibiting the telegraph companies from making a larger charge for messages sent over a short distance than over a long distance in the same direction.

The Telephone Companies and the Government.—In the House of Commons on Tuesday last Mr. Provand asked the Postmaster-General if there was at present any scheme for the purchase of the telephone companies' interest being considered by the Government. Mr. Raikes said that no scheme was being considered by the Government for the purchase of the telephone companies' interest, nor was any such scheme in contemplation.

The Schanschieff Battery.—On the occasion of the opening of the new line of the London and South-Western Railway to Bournemouth several of the saloon carriages in the first train which ran over the line were lit by means of the Schanschieff battery. Great interest was manifested in the light, and we believe that several railway directors expressed their intention of recommending its adoption. We learn that similar lamps are being made for other companies.

Mill Fires in America in 1887.—The annual report of the Manufacturers' Mutual Fire Insurance Company for 1887 contains a record of 167 fires occurring in mills. The report states that the company has done all in their power to encourage electric lighting as being the safest of all artificial lights, and that "a very large number of mills are so lighted." But amongst the list of fires not one is known to have been produced by electric lighting apparatus.

Copper.—Imports of copper into the United Kingdom for February show an increase in value of £395,000, compared with those of February, 1887, and the increase for the past two months is £760,000. At the same time the deliveries to the trade have been much curtailed, and accordingly the stock of copper accumulates. At present advanced prices the amount locked up in the financing of this copper operation must be already reckoned by millions, dipping heavily into the resources of the French banks engaged in it.

Paris.—The Municipal Council are considering a scheme for lighting the whole of Central Paris by electricity, and it is hoped that the work will be completed in time for the Universal Exhibition. A report on the subject has been handed in by M. Lyon Allemand to the Council, and it is proposed in that document that there should be a large municipal machine room under the Central Markets, with wires extending through the metropolitan sewers to the main boulevards and other important arteries.—The Paris Morgue is to be lit by electric light.

The Electro-Harmonic Society.—The first Amateur Concert of this Society was held in the banquet room at St. James's Hall on Friday last, and, in spite of several unavoidable changes in the programme announced, was an unqualified success. In place of Mr. Swinburne, who was to have rendered two pianoforte solos, but who was unfortunately called away on business, the gap was filled by Mr. Gatehouse, who played a violin solo, and Mr. Alfred Izard, the accompanist to the society. Mr. T. H. Harrison was also unavoidably absent, and his place was taken by Mr. J. N. Clarke.

Extract from the Proceedings of the Electric Light Convention at Pittsburg.—"Mr. Smith: I would like to ask Dr. Moses what would be the effect upon the ship of demagnetising the compass. What mischief would it do?—Dr. Moses: The result would be that the ship would float around indefinitely; and when they were thinking that they were going to do most they would find the needle following the movement of the ship, and going round as any needle would if you blow upon it. If, for instance, you attempt to float a needle upon water, and come close to it, you will find it darting off like bacteria in all directions."

Kensington.—At the last meeting of the Kensington Vestry, the following resolution, moved by Mr. John Braye, was carried, and referred to a committee to report:—"That this vestry, in the interest of public safety and economy, apply to the Board of Trade for a license, under the Electric Lighting Act of 1882, for the right of supplying the whole parish of St. Mary Abbotts, Kensington, with electricity for lighting and other purposes, and for power to transfer or lease any portion of the rights and privileges conveyed by the license."—The House-to-House Electric Lighting Company has applied for a provisional order for this district.

The De Khotinsky Incandescent Lamp.—These lamps are now made of the following types:—From 5 to 200 volts, from 4 to 300 candle-power, and to work at a consumption of from 5 to 2¼ watts per candle. So far as we know these are the only lamps at present attainable to work at so high a potential, and we learn from the makers that lamps of very small candle-power are now being made for 200 volts. The life of the lamps is stated to vary from 300 hours at 2¼ watts per candle, up to 2,000 hours at 5 watts per candle. Since the month of August last there has been at work in Berlin an installation of 1,100 lamps at a potential of 150 volts.

Dublin.—A lecture was delivered at Brown-street Schoolhouse on Tuesday evening by Mr. Joseph Farrar, of the Telegraph Department, G.P.O., on "Electricity and Magnetism," accompanied by experiments, in aid of the building fund. The school was fitted up with telephones, electric bells, electric lights, and telegraphs. Amongst the latter was exhibited a recent invention of Mr. Louth, chief engineer (Dublin), which has not yet been made public, but of which he kindly gave Mr. Farrar the use. The lecturer explained the working of electric lights, pumps, electric propelled tramways, &c., and was listened to with the greatest attention by a crowded audience.

Belgian Telephones.—*L'Etoile Belge* says:—"Two new telephone companies have been formed, one in Rosaria, with concession for the Argentine Republic and Uruguay; the other one in Cadiz. This is a double success for Belgium, since these companies, after comparative examination of all telephonic apparatus for subscribers, have adopted the one constructed by Messrs. Mourlon, of Brussels. It is perhaps of all the products of the Belgian industry the one which has the

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most extended market, being used not only in America but also in China, Japan, and even in the Congo, where the network in San Thomé Island has no apparatus but those of this Belgian firm."

Buckingham.—The Buckingham Flour Mills, belonging to Mr. A. C. Rogers, have been fitted with electric light. The dynamo is of the Elwell-Parker type, and is driven by water power from the mill shaft. Edison-Swan incandescent lamps of 16 to 20 candle power, which are used, are fixed in white enamelled metal shades set close to the ceiling. There is also a movable lamp fixed in a lanthorn, which by means of a flexible silk-covered wire cord may be used for stone dressing, examining the machinery of the mill, and also to illuminate the bins, where a light is not always required. The contract has been carried out by Mr. W. Habgood, electrical engineer, West Dulwich.

The Lighting of the City.—At a meeting of the City Commissioners of Sewers, on Tuesday last, a report was brought up from the Streets Committee, recommending that the proposed contract with the Anglo-American Brush Electric Light Corporation for lighting a district of the City by means of electricity be not further proceeded with. Mr. Bridgeman moved the adoption of the report, stating that the recommendation of the committee was in consequence of the opinions expressed at the previous meeting of the court. Mr. Treloar expressed a hope that electric lighting would be adopted in the City. Mr. Harris, Mr. Bell, Mr. Morton, and other members, having spoken briefly, the report of the committee was agreed to.

The Lighting of the Melbourne Exhibition.—The forthcoming International Exhibition to be held at Melbourne will be lighted by means of 800 Brush arc lamps of 2,000 nominal candle-power, and about 3,000 incandescent lamps of 17 candle-power, operated by thirty-seven No. 7L Brush dynamos and seven E2 Victoria machines. The Anglo-American Brush Electric Light Corporation have just contracted with the Australasian Brush Electric Light Power and Storage Company for the supply of the whole of the dynamo machinery and arc lamps required for this extensive installation, and have undertaken to ship all the apparatus by the end of the first week in May.

Exports of Telegraphic Wire, &c.—The Board of Trade returns for last month and for the two months ended 29th February, which have just been issued, show a considerable falling off in our exports of telegraph wire, and of apparatus classed under that category. The following are the values for the first two months of this year, in comparison with the corresponding returns for the two previous years :—

Exports of Telegraphic Wires and Apparatus connected therewith.

	1886.	1887.	1888.
January	£68,623	£14,442	£41,231
February	19,286	44,137	14,051
Two months	£87,909	£58,579	£55,282

Society of Arts—Lectures by Dr. Oliver Lodge.—A short course of lectures on "The Protection of Buildings from Lightning," by Prof. Oliver J. Lodge, F.R.S., to be delivered under the title of the Dr. Mann Lectures, as a memorial of the late Dr. Mann, will be commenced on Saturday afternoon, the 10th inst. The course will consist of two lectures, the first of which will take the form of a slight historical sketch, and will call attention to the outstanding questions, difficulties, and points of controversy in connection with lightning conductors. At the second lecture experimental answers will be given to some of the questions raised, and an endeavour will be made to supply a more complete account of the liability of conductors to side-flash than has yet been attempted. The chair will be taken at 3 o'clock.

Death of a French Electrician.—The Paris correspondent of the *Daily News* telegraphs :—M. Richard, the civil engineer who laid down the first network of telegraphic wires in France, died this morning. When the investment of Paris became inevitable he organised the telegraphic service at Tours in the month of August, 1870. He also laid down so stealthily a wire in the Seine, connecting Havre and Paris, that not half-a-dozen persons suspected its existence. One of these was a peasant, who went and told the Germans that he knew a military secret of the utmost importance, which he could let them have for 5,000f. They gave him the money, but told him that if he was fooling them they would not only take it back, but shoot him. After the war his traitorous act, about which he talked, was denounced, and he was brought to trial and punished. M. Richard of late years was Government expert for all telegraphic and telephonic experiments.

Leamington.—At the last meeting of the Leamington Town Council a correspondence was read between the town clerk and the Midland Electric Lighting Company, in which the company requested to be paid for the street lighting which they were then carrying out. This was refused, on the ground that the terms of the contract had not been complied with. In the course of the proceedings the room was suddenly plunged in darkness owing to a failure of the light. The mayor (Mr. Fell) explained that the mishap arose from five of the six dynamos having been rendered useless by the recent short-circuiting, involving the Midland Electric Lighting Company in a loss of £1,500. The company were, he said, doing their best to remedy the defects, and would have three or four dynamos in operation by the end of the week. Mr. Orton submitted a proposition to give notice to determine the contract if the lighting of the Parade by electricity was not considered to be satisfactory by the 31st of March. The mayor asked Mr. Orton to defer his motion for a month ; and suggested that at the end of that time, if the electric light was not a success in the town, the necessary 12 months' notice might be given to determine the contract. This suggestion was adopted.

The National Telephone Company.—We have received a copy of this company's list of subscribers for the Yorkshire district. The book contains a very interesting plan, showing the existing and proposed systems of trunk wires in the Yorkshire district, and also in the Lancashire and Cheshire districts, with which inter-communication is provided. The following are the principal trunk lines now in course of construction :—From York to Leeds *via* Tadcaster, from Sheffield to Buxton, from Sheffield to Chesterfield, and thence to Nottingham *via* Clay Cross, from Nottingham to Derby and Lichfield. This latter line will place the Nottingham district in direct communication with the Birmingham and Wolverhampton district. From Wolverhampton a line is in course of construction northwards to Stafford and Longton. By means of the existing lines from Longton to Hanley and a new line from Hanley to Buxton communication will eventually be effected between Birmingham and Manchester. The first telephone was placed in Yorkshire about the year 1879, and there are now in operation about 2,000 exchange and 350 private lines. The latest returns of the National Telephone system up to the 31st December last are as follows :—

Total number of exchanges		104
Total number of call offices		192
Number of exchange lines	7,301	
Number of private lines	1,177	
Total number of lines		8,478

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Private House Lighting.—The "Old House," near Warwick, the residence of Mr. G. V. Fowler (of the firm of Fowler, Lancaster and Co., of Birmingham) has recently been fitted with electric light. Motive power is obtained from a Spiel's petroleum engine of 2 horse-power nom. Very good results have been obtained from this engine; it is found to require very little attention, and works economically. The dynamo is by Fowler, Lancaster and Co., and is shunt-wound for charging accumulators. The cells are of the E.P.S. type, the lamps are of 50 volts, and the total number in use is 54. Two of these at the entrance gates are of 50 candle-power, the remainder are of 8 and 16 candle-power. One 200 candle-power lamp has also been provided with the intention of lighting the tennis lawn during the summer evenings. White porcelain switch and fuse blocks are employed, and the fittings throughout are of a very tasteful character. Mr. Fowler reckons that, light for light, the total cost of lighting amounts to about double that previously expended for oil. Messrs. Edmundson and Co., of Dublin and Westminster, have recently completed an installation of electric light at Lord Brassey's residences at Normanhurst and Park-lane. In the latter case only the lamps and wires were supplied, the current being obtained from the Grosvenor Gallery Central Stations.

Telephonic Communication with Ships.—The following is the cutting enclosed in Mr. Unbehaun's letter on this subject (see our correspondence columns):—"The first practical use of the ocean telephone cables that have been laid from the Largs Bay jetty to seaward, for the use of the Messageries Maritimes and the Orient Steam Navigation Company's boats, was made on Monday by the M.M. steamer 'Yarra,' the first vessel of either line that has arrived since the means of communication were perfected. The work of laying the cables was completed on Friday, during a considerable portion of which Mr. Unbehaun, by whom our telephonic department is managed, was engaged on the launch 'Blue Bell' examining the fixtures and appliances of this new departure in telephony in the colony. The communication has been effected in this way. Two separate cables have been laid from the Largs Bay jetty to a buoy, specially fitted up for the purpose, and moored about one mile from the jetty. The cables terminate there, and an attachment consisting of a couple of conical copper tubes has been effected to each cable. The steamers generally anchor within a third of a mile from the site of this buoy, and each of the firms interested (Messrs. Harold Bros. and Messrs. Stilling and Co.) are provided with a portable set of telephones and a drum containing about 700 yards of insulated wire. One end of this wire has attached to it a ring which is slipped over the conical tube at the termination of the cable, and this effects the communication. The work of connecting the cables with the steamers is done by the Steam Launch Company, and the wire unrolls itself from the reel as the launch proceeds from the cable buoy to the steamer. Thus is completed the connection between the steamers, Largs jetty, and Messrs. Harrold's and Stilling's Port and City offices respectively, so that their agents on board the steamers can communicate direct from the boat to Adelaide or the Port as desired. On Monday, when the 'Yarra' anchored, Messrs. Harrold Brothers' cable was paid out to her, and the line was used for the first time from the ocean steamers; a preliminary experiment with it having been tried on Friday by Mr. A. F. Durand, of that firm's Port office from the 'Blue Bell,' anchored some 700 yards from the buoy, when it was found that Adelaide could be distinctly spoken with. On Monday it was stated that it worked exceedingly well, no difficulty whatever being experienced in speaking from town, a distance, owing to the way the wires are connected, of about twenty miles. The practicability of submarine telephony in this Colony, and thereby communicating rapidly, and at the same time distinctly, with the ocean steamers calling at our ports, has thus been demonstrated, and much of the delay and launch-travelling that has hitherto been necessitated by the lack of such means of intercourse will now be obviated."

Coastguard Stations and the Electric Telegraph.—The *Liverpool Journal of Commerce*, March 1, 1888, writes on this subject as follows:—"It is said by those who have paid particular attention to the state of preparedness in Great Britain on the outbreak of war that glaring faults or deficiencies are quickly discovered; and the consequence is that pluck has to stand in the place of science and equipments. There was never, perhaps, a Minister at the head of affairs who was more desirous to secure the peace of Europe than the Marquis of Salisbury; but if the Continental Powers should resort to hostilities, it will be found almost an impossibility for Her Majesty to keep her armed forces out of the fight. But should a war break out, there would be a protest from one end of the land to the other for the immediate connection of all the coastguard stations by telegraph wires with the nearest offices. There are fleets of merchant ships and a vast commerce to protect, and this cannot be reasonably done unless the coastguard officers have the means of communicating with vessels off the coast. Warnings will be found necessary if armed cruisers are to be avoided, but at present this duty cannot be performed. All around the United Kingdom there are coastguard stations perched on commanding positions; but if an officer in charge saw an enemy's ship he might have to send miles by road or along cliffs before a signal station could be reached, and in the meantime captures would be easy of accomplishment in the absence of Queen's vessels. The coastguard officers could be of immense service to the Admiralty and the shipping interests if a system of telegraphy was at their command. War would scarcely be declared before there would be an outcry in the press, Parliament and among the public at the apathy of the Government in not carrying out such a needed aid to the Royal Navy. Our labours in endeavouring to bring this most urgent matter to the attention of all concerned have not, however, been devoid of fruit. In the report of the Royal Commission on Irish Public Works, just issued, the commissioners speak favourably of the importance of telegraphic communication in fishing centres, and in recommending the utilisation of Tory Island in this respect they are sensible of the fact that a submarine cable could be made applicable to the general trade for signalling purposes. There is a feeling gaining currency that delay is dangerous in so far as coastguard stations are concerned. Lord Nelson, in the height of victory, is reported to have said, 'If I were to die this minute, want of frigates would be found stamped on my heart.' In his days those ships were the eyes of the fleet, and ever ready to give chase. A future British admiral, who may be harassed by false information and kept impeded by want of positive intelligence, may some day exclaim in imitation of Nelson:—'My ships are captured in detail by an enemy whose actions I know nothing about, and were I sinking this moment I should cry as the sea engulphed me, "Why did not the Queen's Government give coastguard officers electric communication with the Admiralty?"' We have said that the signalling of merchant ships would leave a profit on the capital expended. Underwriters, chambers of commerce, exchange rooms, and other establishments would buy the reports, independent of British and foreign newspapers. We ask, therefore, as an instalment, a coastguard telegraph system, and the lighthouses and light-vessels will follow as a matter of course."

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ELECTRICAL APPLIANCES USED WITH TORPEDOES AND SUBMARINE MINES.

BY CAPTAIN C. A. M'EVOY.

Whatever may be the future status of torpedoes and submarine mines, and however much their importance may be the subject of doubt and discussion at the present time, no maritime power can afford to entirely ignore them and to trust alone to the older weapons in the operations of war. The low cost of a system of coast defence by means of submarine mines as compared with the cost of guns, fortifications, and ships, must secure their partial or complete adoption by all nations having a seaboard to defend.

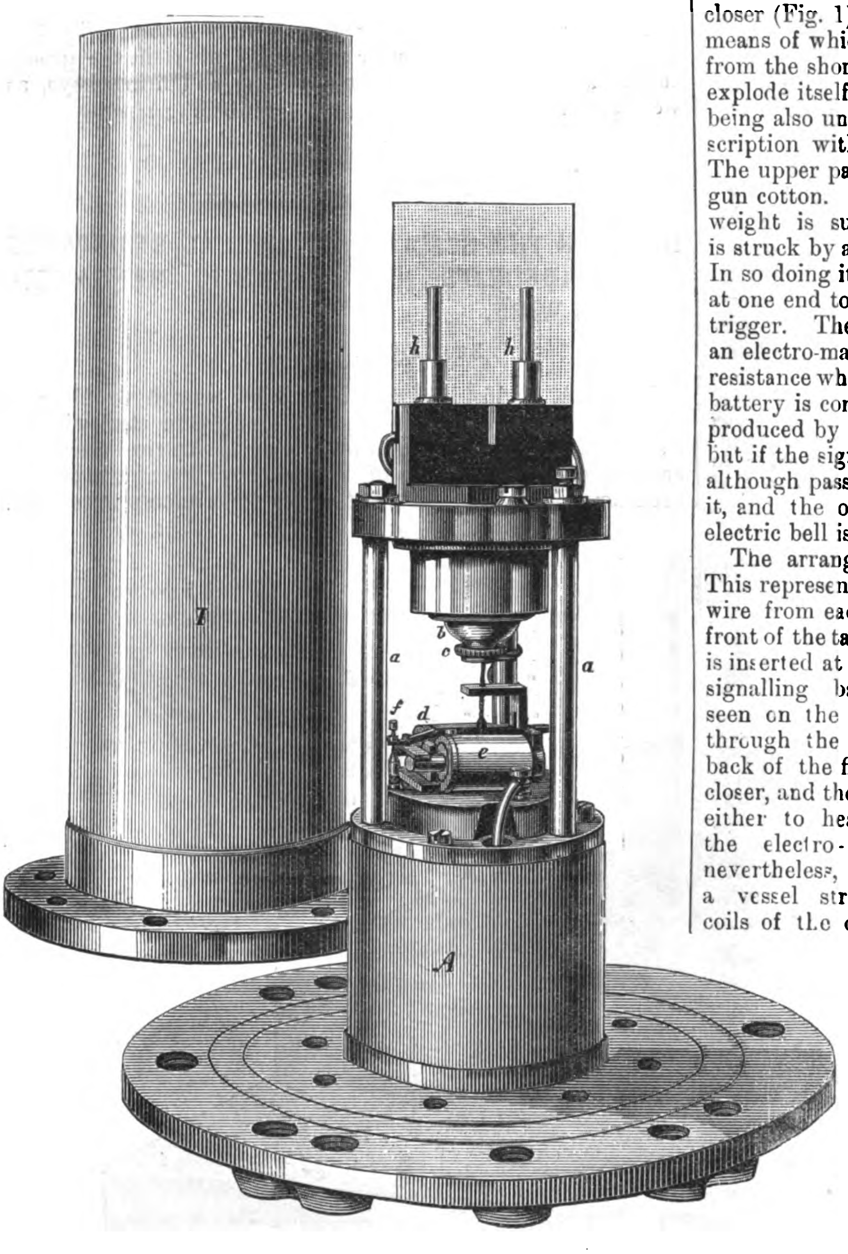

Fig. 1.—Circuit Closer. A. Base piece. a. Frame of circuit closer. b. Inertia weight. c. Adjustable screw for tension. d. Lever connected with armature of magnet. e Magnet. f. Armature contact. hh. Electric fuses. i. Envelope or cover for circuit closer.

The use of submarine mines will form no insignificant part of the means that will in the future be relied on for the defence of our rivers and harbours. The system to be employed will be mainly electrical, and so designed that while friendly vessels may pass over the mines in safety, they can, at will, be changed into a condition of danger to any vessel attempting to pass over them. The following is a description of some of the electrical submarine mining and torpedo stores supplied by Sir W. G. Armstrong, Mitchell and Co., Limited, Newcastle-on-Tyne:—

Electro-Contact Mines.—(Multiple-Main System.)

This system is one of the kind employed for the defence of rivers and harbours.

A group of four or more mines, each with sufficient buoyancy, is moored so that the mines will float a few feet below the surface of the water. All the mines in the group are connected to an iron junction box moored a few feet from the mines by means of short lengths of single-cored cable. A multiple-main cable carrying an insulated conductor to each mine connects the single-cored cables in the junction box with the shore.

Each mine is fitted with an electrical apparatus called a circuit closer (Fig. 1). The circuit closers contain an arrangement by means of which the fuses in the mines may be tested and fired from the shore, and by means of which each mine may also explode itself on being struck by a passing vessel, this action being also under control from the shore. A mine of this description with the outer case removed is shown in Fig. 1. The upper part contains the explosive charge, which is usually gun cotton. About the centre of the iron cylinder an inertia weight is suspended in such a way that when the case is struck by a passing vessel it swings to one side or the other. In so doing it pulls tight a string or chain which is attached at one end to the inertia weight, and at the other to a lever or trigger. The movement of this lever allows the armature of an electro-magnet to be attracted, and this closes a shunt of no resistance which cuts the magnet coil out of circuit. If the firing battery is connected at the shore end the increase of current produced by the fall of resistance immediately fires the mine, but if the signalling current only is on the circuit the current, although passing through the fuse, is not strong enough to fire it, and the only consequence is that a shutter falls and an electric bell is rung at the firing station.

The arrangement at the firing station is shown in Fig. 2. This represents a set of five testing and firing connections. The wire from each mine is brought to one of the terminals on the front of the table. In order to test its electrical condition a plug is inserted at this point which puts the mine in circuit with the signalling battery and the high-resistance galvanometer seen on the top of the case. The circuit is then completed through the galvanometer, through the magnet coils at the back of the firing shutters, the electro-magnet in the circuit closer, and the fuse itself; but the current is not strong enough either to heat the fuse or to pull down the armatures of the electro-magnets. The deflection obtained shows, nevertheless, that the mine is intact. When, however, a vessel strikes the mine and cuts out the magnet coils of the circuit closer as already explained, the current becomes strong enough to pull down the armature of the firing shutter. This causes the shutter to fall, and at the same time throws the bell into circuit. The shutter in falling cuts out its own magnet coils, and at the same time it closes a contact by which the current of the firing battery has to pass. The firing battery is, however, only in circuit when the plug seen on the right hand side is inserted. If this is already in place the mine is fired the moment the shutter falls. If it is not in place, and it is desired to fire the mine, on receiving this signal from the bell, the firing plug is now inserted. If it is desired to reset the mine without firing, it is only necessary to raise the shutter and withdraw the contact plug of the mine. The circuit being thus broken the armature of the electro-magnet in the circuit closer is restored to its original position by the retractile spring.

Double-Main System.

This system, like the multiple-main system, is employed for the defence of rivers and harbours, and differs from that system mainly in the economy of cable it secures. Instead of requiring a separate conductor to each mine, as in the multiple-

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main system, the double-main system has but two conductors for testing and firing all the mines in a group.

The iron junction box contains an electrical step-by-step arrangement that works in unison with a similar instrument

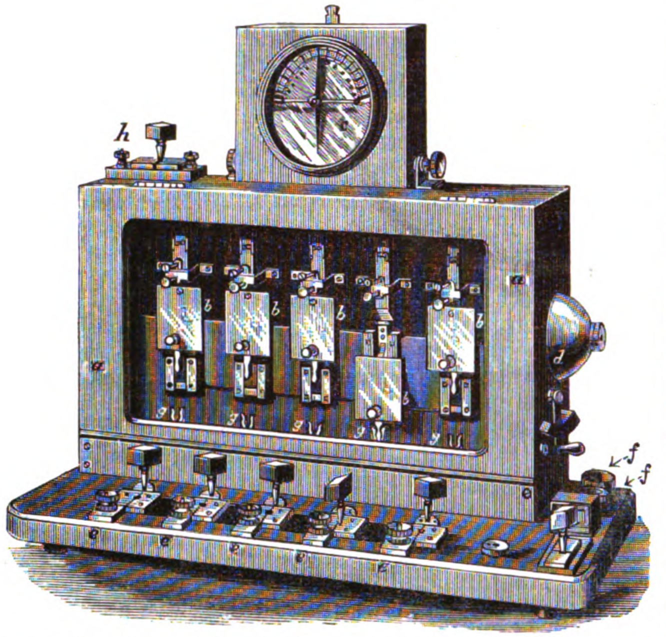

FIG 2.—Signalling or Shutter Apparatus. *aa.* Outer case of apparatus. *bbbb.* Shutters or falling signals. *c.* Galvanometer for testing mines. *d.* Bell for indicating fall of shutters. *eeee.* Mine connections. *ffff.* Battery connections. *gggg.* Spring contacts for switching in firing battery. *h.* Key for switching galvanometer in or out of circuit.

in the double-main system by a magnetic disconnector, a novel device that is free from the objections inherent in the ordinary disconnector—which consists merely of a fine platinum wire within the junction box, and is intended to be fused by the firing current. The difficulty of securing the fusing of the platinum wire disconnector at the instant the fuse in the mine is exploded is entirely obviated by the use of the magnetic disconnector. The junction box contains a set of electro-magnets, one for every mine with which it is connected. These magnets come into circuit successively as the step-by-step movement is actuated from the shore. The firing current pulls down the armature of the magnet coil then in circuit, and cuts out the coils themselves, as in the case already described. When the armature rises again it is caught by a tripping lever and held in a position in which the wires leading to the mine are entirely out of circuit.

The shore instrument in the double-main system (Fig. 3) is provided with a single shutter for all the mines in the group. It has also a bell, galvanometer, testing and firing keys, as well as the step-by-step movement described.

(To be continued.)

NOTE ON THE SPECIFIC ELECTRICAL RESISTANCE OF HADFIELD'S NON-MAGNETIC MANGANESE STEEL WIRE.

BY PROF. J. A. FLEMING.

Mr. R. A. Hadfield having been kind enough to place in my hands a sample of non-magnetic manganese steel wire for examination, a determination of its specific electrical resistance and coefficient of variation of resistance with temperature has been carefully made. The first set of experiments were made

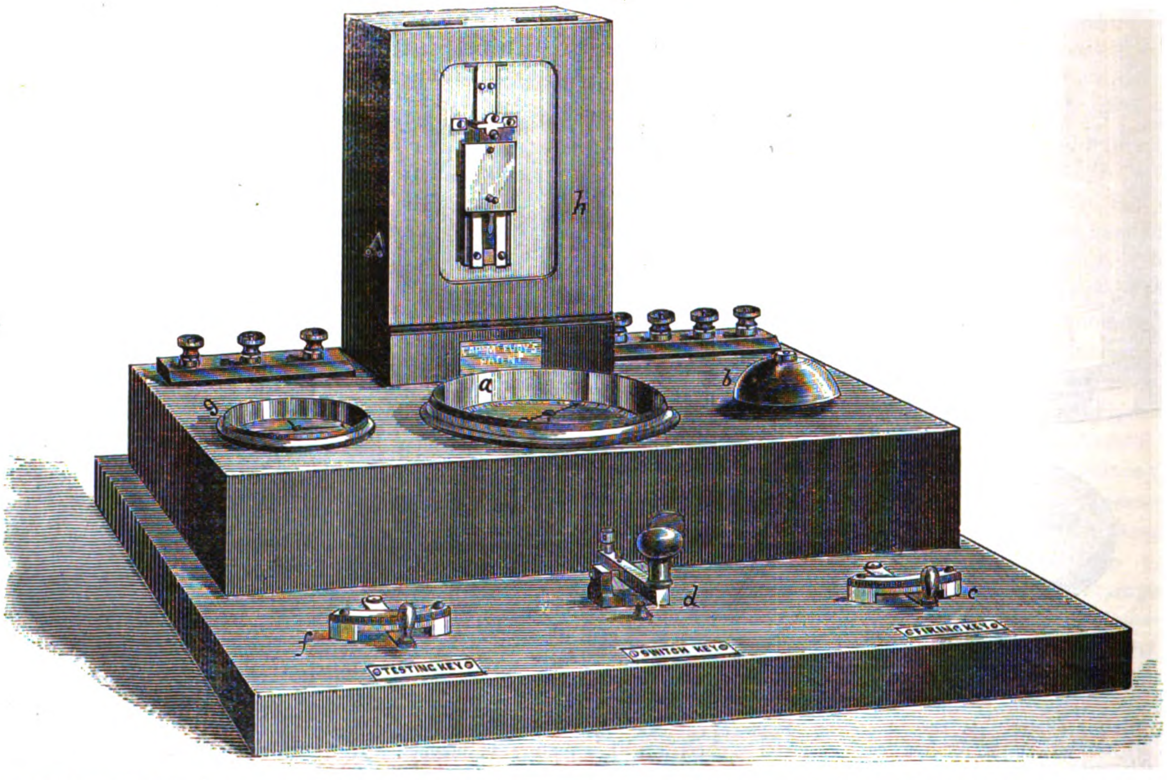

FIG. 3 shows the shore instrument for double-main system. *a.* Indicating disc with pointer, showing which mine is in circuit at the time. *b.* Bell *c.* Firing key. *d.* Switching key *f.* Testing key. *g.* Galvanometer. *h.* Shutter box.

on the shore, very much after the fashion of the old Breguet "A B C" telegraph. By means of these two instruments all the mines in a group may be separately tested and fired through the double-main cable.

When any one of the mines in a group is exploded it is necessary that it should be cut out of the circuit, or an "earth" would be established through the broken wire. This is done

by Mr. R. Berncastel, in the Physical Laboratory, University College, London.

A length of the manganese steel wire equal to 330·85 centims. was taken, and the mean diameter determined by gauging in several positions, and also checked by a determination of the specific gravity. The mean of several determinations gave ·086 centim. as the mean diameter of the wire.

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The resistance was determined at several temperatures between 0°C. and 100° by heating the wire in an oil bath, with the following results :—

Temp.	Resistance in B. A. units.
2°·66 C.	4·045
13°·25 „	4·089
52°·60 „	4·284
94°·30 „	4·503

Plotting these resistances as ordinates to temperature as abscissæ, we find a nearly straight line. Expressing the resistance as a function of temperature in the form

$$r = a + b\,t + c\,t^2,$$

we find, as the values of these constants,

$$a = 4{\cdot}03362$$
$$b = {\cdot}004337$$
$$c = {\cdot}00000696.$$

and the resistance R_t at t°C. in terms of the resistance R_0 at 0°C. is

$$R_t = R_0\,(1 + {\cdot}001076\,t + {\cdot}00000173\,t^2).$$

Calculating back the resistances at the observed temperatures we have the following agreement between the observed and calculated resistances—

Temp.	Resistance calculated.	Resistance observed.	Diff.
2°·66	4·045	4·045	·000
13°·25	4·092	4·089	·003
52°·6	4·281	4·284	− ·003
94°·3	4·505	4·503	·002

The specific resistance at 2°·66 C. is then $\frac{4{\cdot}045 \times {\cdot}00567}{330{\cdot}85}$ = 69·3 microhms per cubic centimetre (B.A. units), or at 0°C. is 69·1 microhms per cubic centimetre, measurements being in B.A. units. Translating this into Legal or Congress ohms by multiplication by ·9889 we have for the specific resistance of this sample of manganese steel = 68·3 legal microhms per cubic centimetre.

The coefficient of variation of resistance with temperature from the above experiments is ·12 per cent. per degree centigrade.

A similar experiment was made for me by Mr. A. H. Bate, working independently on a portion of the same wire. A length of 28·25 inches of the wire was measured off. The mean diameter was taken in a very large number of places, and found to be ·0795 centim., the lesser diameter in this case being accounted for by the fact that the wire had been softened (by sudden cooling), stretched, and cleaned, in order to permit of a more careful determination of its mean diameter.

The mean area of cross section was ·004962 square centimetre. The resistance at 14° C. was 0·991735 legal ohm. Hence, the specific resistance at 14° C. is—

$$\frac{{\cdot}004962 \times {\cdot}991735}{28{\cdot}25 \times 2{\cdot}54} = 68{\cdot}6 \text{ legal microhms per cubic centimetre.}$$

The resistances of another length of the wire was taken at different temperatures and found to be as follows :—

Temperature.	Resistance. (Legal ohms.)
7°·07 C.	2·4103
7°·30 „	2·4105
35°·12 „	2·4929
33°·72 „	2·4869
58°·20 „	2·5630
54°·70 „	2·5515

The mean coefficient of variation of resistance with temperature from these observations is ·1224 per cent. per degree centigrade.

If we reduce the specific resistance at 14° C. to that at 0°, we find it to be 67·4 legal microhms per cubic centimetre. The mean of the results by the two observers is nearly 68 microhms per cubic centimetre.

As a means of comparison, we may place alongside of this number the average values for annealed copper and German silver—

	Specific resistance in Legal microhms per cubic centimetre at 0° C.
Annealed copper	1·624
German silver	20·9
Platinoid	32·8
Platinum silver	24·36
Manganese steel	68· (about)

Accordingly, Hadfield's non-magnetic manganese steel has a specific electrical resistance some three and a-quarter times that of German silver.

The coefficient of variation of resistance with temperature is about three times as great as that of German silver. For the sake of comparison we place alongside of it those of the following alloys. :—

Average percentage variation of electrical resistance per 1° C. between 0° C. and 100° C.

Platinoid	·021
Platinum-silver	·031
Gold-silver	·065
German silver	·044
Cast iron	·080
Manganese steel (Hadfield)	·122
Copper	·388

This sample of manganese steel was to all ordinary tests entirely non-magnetic, and was not in the least attracted by a powerful permanent steel magnet.

The great specific resistance of the wire would make it very useful in electrotechnics, if the working of the wire did not present great difficulty. The wire is exceedingly hard and can only be softened by heating to a bright red heat and cooling it suddenly. Slow cooling renders it hard again. If, however, the wire can be prepared in a soft state, then its high melting point and consequently great current-carrying capacity, combined with its high specific resistance, might make it a useful material to use for resistances on which to run dynamos in testing. Its specific resistance is about 6—7 times that of iron wire. It would not, however, be a good material for standard coils, on account (apart from the difficulty of working) of considerable variations in electrical resistance of different samples, and also on account of its relatively high coefficient of variation. It is certainly very remarkable to note the extraordinary change in electrical and magnetic properties produced in iron by the addition of 10—20 per cent. of manganese.

ALTERNATING CURRENT ELECTRIC MOTORS.*

BY DR. LOUIS DUNCAN.

The alternating system of electrical distribution, possessing as it does many advantages for distributing electrical energy over extended areas, possesses certain disadvantages, among others that of not, at present, allowing the use of electric motors for the distribution of power.

Our knowledge on the subject of alternating currents is largely due to the work of M. Joubert and Dr. John Hopkinson. The latter showed first that alternating dynamos could be coupled in parallel, and afterwards that one dynamo could be used to drive another as a motor. He brought forward experiments tried by Prof. Adams and himself, in which one dynamo had driven another, the latter doing mechanical work. Mr. Siemens at the same time, in 1885, described experiments where he had driven both alternating dynamos and ordinary series motors by alternating currents. Dr. Hopkinson's mathematical work assumes that the curve representing E.M.F. is a simple sine curve ; that is, that $E = E_0 \sin 2\pi \frac{t}{T}$. It is importan to notice, however, that his principal conclusions do not depend upon this assumption, but would be true if the E.M.F. were any periodic curve. Since that time nothing of importance has

* Read before the American Institute of Electrical Engineers, February 14, 1888.

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appeared on the subject excepting two short papers—one by Mr. Kapp on "The Maximum Work Obtainable from a Given Source of E.M.F.;" the other by Mr. Blakesley on "Conditions of Maximum Efficiency in the Case of Transmission of Power by Alternating Electric Currents."

In all of the mathematical work done on this subject it has been assumed that the various E.M.F.'s may be represented by a sine curve, and that only simple electro-magnetic actions enter into the problem. I do not believe that these assumptions are true. Since Joubert's experiments made in 1881 it has been known that the curve of E.M.F. of a Siemens alternating dynamo, where the external circuit had no statical capacity, was very nearly a sine curve. With some of the machines used to-day, and under the much more complicated conditions of distribution, this is probably not even approximately true. Neither is it true that the statical actions of the different forms of wire upon each other in the transformers can be neglected. Messrs. Hutchinson and Wilkes and myself have lately experimented on this subject, and we have obtained the curves for the currents in the secondary and primary circuits under many conditions. These observed results do not agree with the results of calculation in the few cases that we have worked out. Until we have fully satisfied ourselves in this matter I will avoid any but the simplest mathematical work.

Alternating-current motors are not in successful use; let us try and find out the difficulties they present and attempt to suggest plans for overcoming them.

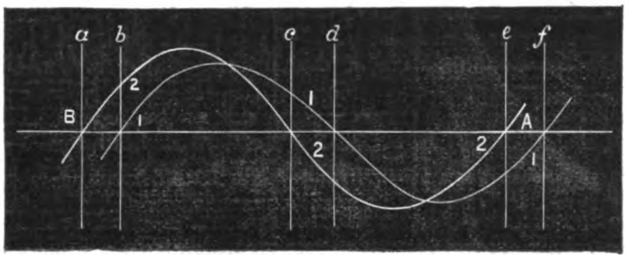

FIG. 1.

The energy being transformed at any moment in any dynamo-electric apparatus—in which I include dynamos, motors, transformers, &c.—is equal to the product of the current by the electromotive force produced by the apparatus. This is true for alternating as well as for direct-current apparatus. Generally we have:—

Work = E C. This is + for a dynamo – for a motor.

In alternating circuits E and C are constantly changing. If we represent them by curves, as before, we must multiply each value of C by the corresponding value of E, and if we add all these together from A to B (Fig. 1) we will have the work done by the current in one period. Now, if we consider values above the horizontal + and below it –, we have from *e* to *d* a + value of the product, from *c* to *d* a – value, from *c* to *b* a + value, from *b* to *a* –. The total work done then is [*e* to *d*] + [*c* to *b*] – [*d* to *c*] – [*b* to *a*].

Now we see that if we shift I I forward [towards B] or pull I back we have this work less, even though the curves themselves remain the same size. Now, this is one of the exceptions I take to the alternating system. In a direct system as the work decreases the current decreases, and the heating of the mains becomes proportionally less, since it varies as C^2; for example, if the maximum loss in the mains of a direct current plant were 10 per cent. of the average I imagine that the average loss is not over 3 per cent. In an alternating-current plant a decrease in the consumption of energy decreases the current very little; it simply shifts its position with respect to the E.M.F., and the heating, approximately equal to $\frac{C_0^2}{2}$ R, remains nearly constant. A maximum loss of 2·5 per cent. would probably mean an average loss of at least 2 per cent. This same remark applies to transformers and motors, and the average efficiency of the former will be considerably less than the maximum efficiency.

A distinction between continuous and alternating-current apparatus is this:—In continuous-current dynamos and motors the cores making up the windings of the armatures make different angles with the lines of force in the field, and the result, when the armature rotates, is a constant E.M.F., fluctuating but little; in alternating dynamos and motors the alternate coils are symmetrical with respect to the alternate poles, the remaining coils being symmetrical with respect to similar poles of opposite signs. The result is a varying E.M.F., changing as has been shown. In dynamos the effect of this is that the power applied either varies from zero to a maximum each period, or the armature changes its speed at different points and oscillates with a period equal to that of the E.M.F.

FIG. 2.

Let us now consider what takes place in the case of two motors, one continuous, the other alternating, one between mains where a constant continuous E.M.F. is maintained, the other where there is a constant alternating E M.F. In the first case representing current and E.M F. by curves, as we have been doing, we will have two straight lines, Fig. 2, one above the other below our horizontal axis, the former representing current, the latter the counter E.M.F. of the motor. Reckoning time along the axis we have for the energy transformed in the interval from *a* to *b* = – C E. As this is – it means that electrical is transformed into mechanical work.

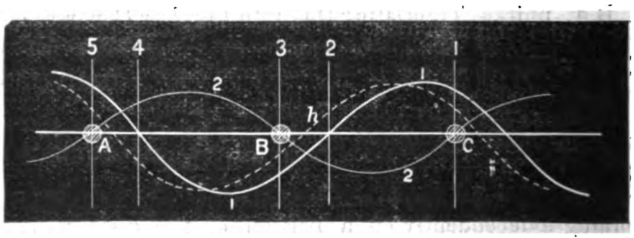

FIG. 3.

Now, let us consider an alternating-current motor built like an alternating dynamo, the field excited by a continuous current. If A B C (Fig. 3) are the poles of the field-magnets, supposed to be excited by a continuous current, then the curve I I will represent the counter or motor E.M F. If our motor is running slowly there will be two or three reversals of

FIG. 4.

current in the time it takes a coil to go from A to B (Fig. 4), and the product C E will be nearly zero, the positive and negative parts being almost equal. Whether it is + or – is somewhat a matter of chance, and if it is – from A to B it will very likely be + from B to C. Thus the armature is pushed first in one direction then in the opposite, and there is no definite tendency for it to rotate as a motor. This brings us to our first difficulty, a simple alternating-current motor will not start itself. Let us suppose, however, that it has been started by some means, and has reached such a speed that in the time of a reversal a coil shall have moved over the distance between two similar poles. We will have the state of things in Fig. 3 and

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the armature will continue to rotate. Now the position of the curve I I is fixed, we will consider the position of I as determined by the position of the armature coils when the current in them is zero; for instance, if the speed increases a little the curve will advance as shown by the dotted line. The total work transformed is the product of the two curves; from 1 to 2 it is −, from 2 to 3 it is +, from 3 to 4 −, from 4 to 5 +. The result is − [1 to 2 + 3 to 4] + [2 to 3 + 4 to 5]; part of the time, then, the machine is working as a dynamo, part of the time as a motor; the difference of the values represented by the brackets gives the mechanical work that is really available. Now while the available work is the difference of these areas, the difference becoming small as the load is decreased, the heating is the *sum* C^2 R for all the values of the current, and is independent of the position of its curve, as has been pointed out above.

Looking at the figure again we see that from 1 to 2 the armature is pushed forward by the current in the line; from 2 to 3 it is pulled back, since it is acting as a dynamo feeding into the line, and can only get the energy to produce the current by decreasing its speed and drawing from its energy of motion. The armature oscillates then, and it is evident that the amount of its oscillation depends on the kind of work it is doing. If it is driving heavy wheels or machinery having considerable inertia, it will only have to slow down slightly when it becomes a dynamo. If it is lifting weights the amount of oscillation will be considerable.

It is evident that there is a certain position of the curve I that will make the available work a maximum. If the motor is doing all of its possible work the curve will take up this position. As the load is decreased the speed will increase for an instant until the curve has shifted forward into such a position that the sum of the products E C is equal to the work done. In fact, we can plot a curve representing

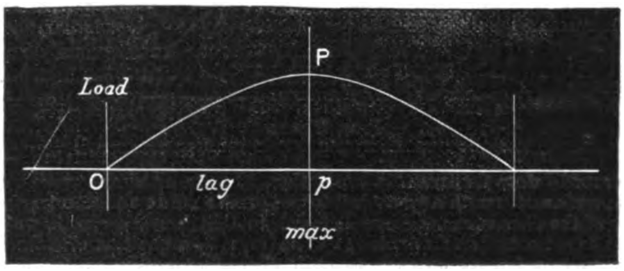

Fig. 5.

values of the distance from the point the current curve crosses the axis, to the same point when the work is zero, corresponding to different loads.

Now, the value of this lag, as we will call it, cannot be greater than O P (Fig. 5), for although we might extend our curve on the other side, yet a slight increase in our load will cause the armature to fall back, decreasing the available work, and suddenly stop. It is, in fact, in unstable equilibrium.

Suppose we have found the value of the lag that will give us a maximum value of the work, and have calculated this value by the ordinary mathematical methods employed, the real work we can obtain is less than this, for the current curve oscillates on both sides of the maximum, supposing we *could* work at the maximum—that is, it is only for a very short time in the best position; so that if we take the sum of the work for a period, it will be less than the calculated maximum. In reality we must work slightly in advance of the maximum, for if we were too near it the curve would fall behind P, and will then be in unstable equilibrium and stop. The practical maximum will then vary according to the amount of the oscillation—that is, according to the nature of the work being done.

It seems to me that the possible forms of alternating motors are:—(1) Ordinary series motor; (2) An alternating dynamo reversed, the field being excited by a continuous current; (3) An alternating dynamo reversed, the field being excited by the alternating current first corrected by a commutator on the shaft; (4) The arrangement suggested by Prof. Thomson, which is described below.

In the first type—a series motor—there is no difficulty in starting; the motor will start of itself. There are these troubles, however; the armature and field must both be thoroughly laminated to prevent eddy currents; the magnetism of such large masses of iron being rapidly reversed will cause losses unless both field and armature are far from saturation; that is, the mass must be great. Again, Mr. Kapp has shown that to obtain the maximum work we must have, approximately, the counter E.M.F. of the motor equal to the E.M.F. of self-induction—a condition almost impossible to realise in practice. The motor must be governed in some way, as it will not govern itself.

The alternating motor with a field fed from the alternating circuit, the current being commutated, will start itself. I do not know if this has been generally recognised. If, in Fig. 6, A and B are poles and C one of the armature coils, the effects of the currents will be as shown by the two sets of signs. The effect of either arrangement is to move the armature in the direction of the arrow. When C gets opposite A the commutator changes the relative directions of the currents in C and A, and C is repelled by A and the armature continues to rotate. The maximum work will, I think, be done when the speed is such that a reversal takes place in a distance A to B. The mathematical investigation is difficult, and until I am satisfied as to the assumptions usually made I will not attempt it. We have as an advantage of this type that it will start itself; a disadvantage is that the fields must be carefully laminated, there is loss in reversing them, and there will be for some speeds considerable sparking at the field commutator. I should not imagine, either, that the work obtainable from such a motor would be as great as if its field were fed by continuous currents.

The motor obtained by reversing an ordinary alternating dynamo has advantages and disadvantages. It perfectly regulates itself, and the field-magnets need not be lamented; that is it can be made cheaply. It will give a greater output from

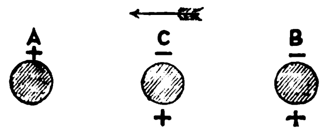

Fig. 6.

a given source of current than corresponding machines of either of the types already discussed. Its disadvantages are that it must be started independently. We must have a continuous current to excite the field, and if a load having any considerable inertia be suddenly applied the motor will stop. This last objection, by the way, will apply to the type of motor previously discussed, provided, as I have supposed, the maximum work is obtainable when the counter E.M.F. has the same period as the applied E.M.F.

Let us see what means we can employ to start the motor and excite the field. We could start by passing the commutated alternating current through the field, as in the second type of motor discussed, changing our connections when the proper speed is obtained, so that a continuous current from some external source passes through the field and the alternating current is shut off from it. Another way would be to have on the same shaft with our main motor a motor arrangement, such as was described by Prof. Elihu Thomson in his valuable paper on Alternating Current Phenomena, read before the institute. With this arrangement we can do more than start the motor. Prof. Thomson pointed out that when this auxiliary motor reached a certain speed it would produce a continuous current in the external circuit of its armature. This current could be used to excite the field of the main motor. By properly proportioning the number of coils in the main and auxiliary motors, this continuous current would be produced just when the motor had arrived at its proper speed, and it is evident that we can make this current operate an automatic device to make the circuit of the main motor at this moment. I should imagine, however, that a motor made in this way would be expensive and not particularly efficient.

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What seems to me the simplest, cheapest and most efficient means of running alternating-current motors is this. Build the motor on the same general plan as the dynamo, with such modifications as the different conditions of working impose, and start it and excite the field-magnets from a continuous-current circuit, run with our alternating circuit, supplied with current by a dynamo at the central station. If we wish to distribute 500 horse-power our continuous circuit should have a maximum capacity of about 50 horse-power. To start the motor we should have the following arrangement:—There should be two breaks in our armature circuit, one between the regular brushes of the machine, the other at a commutator for the continuous current. At this second break the two ends of the circuit should be taken to alternate bars of the commutator, the number of bars being such that the direction of the current is reversed every time a coil passes a pole. The alternate bars are normally connected by a metal ring pressed against them by a spring. In this case we will have the normal circuit just as if there were no continuous-current commutator. On the motor would be a switch-board that would accomplish the following things:—If we wish to start we turn the handle of the switch to a certain position; this will short-circuit our regular brushes, and by the aid of a couple of levers will drop the continuous-circuit brushes on the commutator, at the same time pulling away our metal ring. The motor will then start as a continuous-current motor. When it has reached its proper number of revolutions, or is above it, turn the handle a little further; the continuous current brushes will be raised, the metal ring will connect the commutator bars, and the alternating circuit will be made and the motor will continue to run and will do work.

Now, I consider that the advantages of this plan are these:—It makes the motor simple and cheap to build; it will be more efficient and have a greater output than the other motors that have been discussed; the currents to excite the fields will have to be supplied anyhow, and they cannot be supplied more economically than from the central station; being simpler there will be less liability of derangement.

The motor described by Prof. Thomson that I mentioned above consists of field-magnets through which the alternating current flows, with an armature not in any way connected with the external source of current, but which has currents induced in it just as if it were the secondary of a transformer. The circuits of all of the armature coils are open excepting one that is in such a position that the current induced in it will be repelled by the pole-pieces. In this form I do not think the motor will be particularly efficient or give any considerable output. It is possible that the principle may be further developed to give a considerable output, but I do not believe that any motor in which the field is fed by alternating currents can be cheaply made, although this is a matter of which I have no experience.

To prevent motors stopping when the load is thrown on it would only be necessary to drive the load from a friction pulley on the shaft of the motor. The pulley should be so adjusted that it will turn just before the motor falls behind its point of its maximum work.

It is possible that all of the plans I have suggested have been tried by the different inventors who are at work on this subject. If a motor of each type that I have mentioned were built and proper experiments were tried upon them, we would —provided we had the ability to interpret and apply our results—have the data necessary to design the best possible machine of each type, and if we build these it should settle the question as to which form will be the best. There is no necessity in building an indefinite number of motors to experiment with. It is too much the custom, if we wish to design a dynamo for instance, to build twenty different ones and see which is best. One machine, with proper experiments and deductions, should put us on the right track.

Dr. Holmes once said that when he had written anything that pleased him it immediately seemed very old indeed. I, with humility, feel much the same way, as if what I had said this evening is so apparent that everyone must have known it. I can only hope that some of the suggestions I have made will help the development and final successful application of the alternating-current motor.

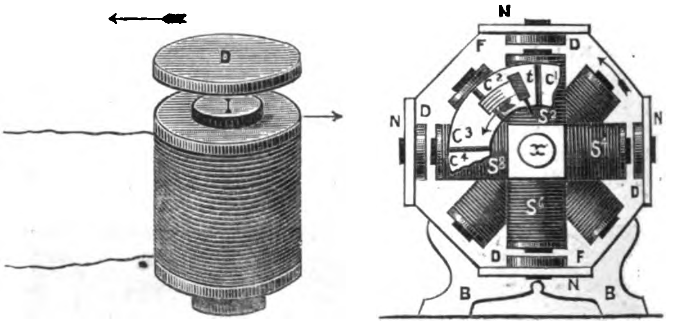
DISCUSSION.

Mr. CROCKER: There are two or three practical points that suggest themselves to me. In the first place, Dr. Duncan speaks about the great cost of a laminated field, and he speaks of it as if it were practically a bar to the use of laminated fields. If I were going to make a wrought-iron field, or if I were bidding for a contract to make wrought-iron fields, I would prefer to make them laminated rather than of forging or any other form of wrought iron that I have ever come across. So far as I am concerned, I prefer the laminations. I have been experimenting somewhat myself in this direction, and was quite pleased with that feature of the alternating current motors, viz., that they *did* involve laminated fields.

Lieut. F. J. PATTEN: Dr. Duncan has shown us that the curve of counter-electromotive force has a variable position with respect to the mean, *i.e.*, oscillating from side to side, and I wish to ask whether any such oscillation takes place or not provided the motor is running under a constant load.

Dr. DUNCAN: I think the oscillation certainly would take place no matter what load is on the motor, because in a part of every period—and a period takes place every one three-hundredth of a second—the motor is not a motor at all, it is a dynamo. That is, it is absolutely putting current into the main line. The only way to get the energy and throw that current into the main line is by decreasing its speed and drawing from its energy of rotation. Therefore, where it is in those areas it will slow down in speed. Where it is in the larger areas it will increase its speed; but the oscillation will occur whether the load is constant or not.

Lieut. PATTEN: I have designed a form and made some elementary tests of a motor of the kind suggested by Prof. Elihu Thomson in his



FIGS. 7 AND 8.

paper read before the Institute last spring. I have always regarded Prof. Thomson's motor with a great deal of admiration. It would seem from some of the discussions we have listened to that whatever work we are going to get out of an alternating system must be a question of difference between two factors opposed to each other—the self-induction of the circuit and the power generated as well as the heating. Inasmuch as all our results must be due to the difference between the two quantities, I have have worked upon that line, trying to give that difference its greatest possible chance to do some work. If you will remember, Prof. Thomson's motor, as Dr. Duncan has explained it to-night, consists in a fixed field and a revolving armature, the circuit of which was closed when it came into position of action; at that point the circuit is momentarily closed.

Fig. 7 illustrates this principle. S is a solenoid with a soft iron core, I and D a closed circuit of high-self inductive capacity, preferably a copper disc. When alternating currents are sent through the coils of the solenoid S, and the centre of the disc D is not immediately in the prolongation of the axis of the solenoid, there is a tendency to separate, as indicated by the two arrows. As in all forms of alternate-current dynamo-electric machinery the effective effort is always due to a difference between two unequal and opposing actions, so in any machine in which the principle thus described finds application the rotary torque or moment of rotation will be due only to a difference of two efforts, as shown in the preceding analysis, and the machine here illustrated is a simple mechanical arrangement of parts, the purpose of which is to cause this tangential effort, however small, to work at a possible maximum of advantage. Those who recall the forms of machine illustrated in a former lecture and based upon this principle will remember a form of machine not differing widely from the ordinary direct-current machine. The armature placed at the centre of the machine consisted of a number of coils of high self inductive capacity, the different circuits of which were closed in succession as they arrived in the position of maximum repulsive action. In the machine I have designed the application of the same principle is reversed, with the apparent effect of producing a more continuous rotary effort as well as a greatly increased moment of rotation by virtue of placing the point at which the effort is applied farther from the axis of rotation, and thereby giving to the force at work, however small, a much greater lever arm. Figs. 8 and 9 are end and side elevations of the machine, and Fig. 10 is a diagram of circuits and connections. A polygonal frame F F F is connected by lateral strips N N, and all is supported upon the base B B. Secured to the lateral strips N N are two sets of copper discs D D and *d d*. These discs constitute the armature of the machine; they are arranged peripherally, as shown, fixed to the frame structure, and con-

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sist of circuits of high self-inductive capacity that remain permanently closed.

A spindle x x (Figs. 8 and 9) carries a revolving switch, C^1C^2, or sunflower, which is secured to the spindle and turns with it. This sunflower commutator constitutes one terminal of the machine, while an insulated ring b +, and its contact brush secured to the support P P, constitutes the other. Under each set of discs, D D and d d, and secured to the spindle x, is a set of solenoids, those of one set being placed at an angle of 45 degrees to those of the other set, from which it results that these two sets of solenoids will each come alternately into action with respect to its own set of copper discs. Each set of solenoids has its four coils connected in series and the two sets are arranged in two independent circuits. Both have one terminal secured to the contact b +, and the

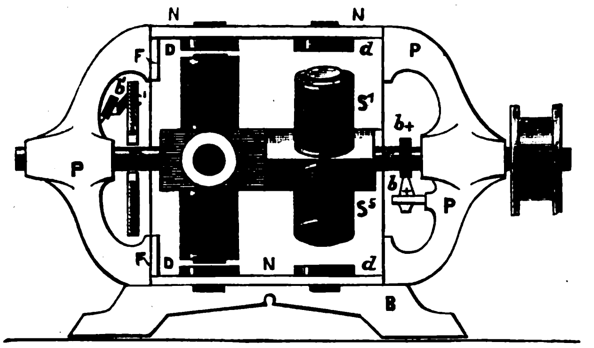

Fig. 9.

other terminal to the alternate segments of the revolving sunflower. This system of connections is shown in Fig. 10, in which the eight-part commutator is shown with alternate segments connected to each other in separate series. The coils S^1, S^3, S^5, S^7, form one set of revolving solenoids connected in series from the rubbing contact b +, which forms one terminal of the machine, to the commutator segment C^1, and thence to all the odd-numbered segments. In like manner the other set of solenoids S^2, S^4, S^6, S^8, are similarly connected in series to all the even-numbered segments, C^2, C^4, C^6, C^8. From this arrangement it results that, as the spindle revolved, carrying these solenoids as a sort of fly-wheel, the alternating current will be sent in rapid succession first through one set of solenoids and then through the other, and by suitably placing this commutator upon the spindle it can be made to send the current through the different sets of solenoids during the periods of maximum effort of repulsion between each set and its corresponding set of copper discs.

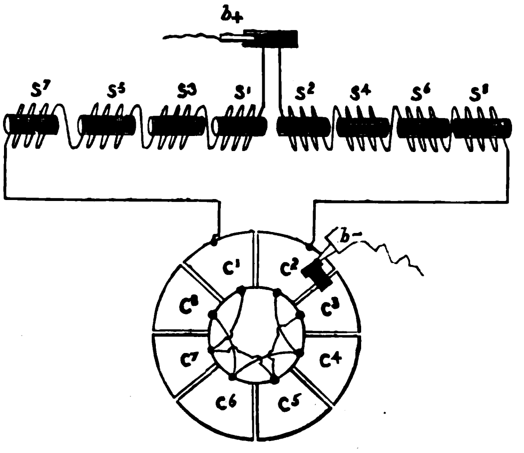

Fig. 10.

The moment of rotation is evidently a maximum under this system of construction, and by increasing the number of sets of solenoids that follow each other in action the effort of the rotary torque may be made nearly continuous and constant.

It is evidently not contemplated that this motor shall drive horse cars. Its efficiency is not high, and its form renders such an application quite impossible; but it can find a place in the smaller industries, where light motors fill a definite requirement, and render an alternate-current circuit a paying one during the working hours of the day.

Mexico and the Synchronising of Public Clocks.—The authorities of the city of Mexico are making arrangements to have one bell in each of the church towers of the city attached by means of electric wires to the clocks in the cathedral, so that the correct time may be given by each clock simultaneously every quarter of an hour.

BOOKS, &c., RECEIVED.

"Munro and Jamieson's Pocket Book of Electrical Rules and Tables." Fifth Edition. (London: Charles Griffin and Co. 1888.)

"Le Wattmètre et son Maniement." (Ganz and Co., Buda-Pesth.)

"Journal of the Society of Telegraph-Engineers and Electricians." Part 70. (London: E. and F. N. Spon.)

"Electric and Pneumatic Bells; their Construction, Fixing, and Repairing, with Price List of Electrical Apparatus." (Gent and Co., Faraday Works, Leicester.)

MEETINGS OF SCIENTIFIC SOCIETIES.

TO-NIGHT (FRIDAY), March 9th.

Institution of Civil Engineers.

7.30 p.m. Students' Meeting. Paper, "The Prevention and Extinction of Fires." By Mr. Alfred Chatterton, B.Sc., Stud. Inst.C.E.

Royal Institution.

9 p.m. "Discourse on S. T. Coleridge." By Mr. Leslie Stephen, M.A.

SATURDAY, March 10th.

Royal Institution.

3 p.m. Lecture, "The Modern Drama: (1) French." By Mr. Wm. Archer.

Society of Arts.

3 p.m. Lecture on "The Protection of Buildings from Lightning" (1). By Prof. Oliver J. Lodge, D.Sc., F.R.S.

MONDAY, March 12th.

Society of Arts.

8 p.m. Cantor Lecture IV., "Alloys." By Prof. W. Chandler Roberts-Austen, F.R.S.

TUESDAY, March 13th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion, "Economy of a non-condensing steam engine—simple, compound, and triple." By Mr. P. W. Willans, M.Inst.C.E.

Royal Institution.

3 p.m. Lecture, "Before and After Darwin" (9). By Mr. G. J. Romanes, M.A., &c.

Royal Victoria Hall (Waterloo Bridge-road, S.E.).

Lecture, "Electric Bells." By Prof. Sylvanus P. Thompson.

WEDNESDAY, March 14th.

Society of Arts.

8 p.m. Ordinary Meeting. "Agricultural Education and Dairy Instruction." By Prof. John Wrightson.

THURSDAY, March 15th.

Chemical Society.

8 p.m. Meeting.

Royal Society.

4.30 p.m. Ordinary Meeting.

Royal Institution.

3 p.m. Lecture, "Microscopical Work with Recent Lenses on the Least and Simplest Forms of Life" (2). By the Rev. W. H. Dallinger.

FRIDAY, March 16th.

Society of Arts.

8 p.m. Indian Section. "The Origin, Progress, and Influence of Universities in India." By F. J. Mouat, M.D.

Royal Institution.

9 p.m. Discourse on "The Structure, Origin, and Distribution of Coral Reefs and Islands." By Mr. John Murray.

SATURDAY, March 17th.

Royal Institution.

3 p.m. Lecture, "The Modern Drama: (2) Scandinavian." By Mr. William Archer.

Society of Arts.

3 p.m. Lecture on "The Protection of Buildings from Lightning" (2). By Prof. Oliver J. Lodge, D.Sc., F.R.S.

Physical Society.

4 p.m. Two Papers by Profs. Ayrton and Perry.

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PROSPECTS OF THE ELECTRIC LIGHT AMENDMENT BILL.

While making due allowance for the ease with which people believe what they wish to be true, there appear to be reasonable grounds for Lord THURLOW'S confident expectation that his Electric Light Amendment Bill will become law in the present session of Parliament. A more encouraging sign, perhaps, is to be seen in the fact that people who cannot be suspected of relishing the prediction have already resigned themselves to its early fulfilment. Foes as well as friends of the new illuminant are joining in the demand to give it a fair trial, and if the former still entertain a lingering hope that it may fail, they are wise in promoting a measure which will bring the issue to the test of practical experience without further prolonging their doubts and anxieties. Indeed, the Electric Light has latterly made such progress, in spite of legislation, that the gas interests may well be desirous of putting it under some legislative restrictions. It would never do to let the purveyors of the rival light discover that they could dispense with the regulations and limitations under which gas, to some extent, is supplied; and probably on this account, too, the gas light journals have found it expedient to say a good word for Lord THURLOW'S Bill. At all events, whatever may be the explanation, there seems to be no opposition to the measure outside of Parliament. Any latent objection on the part of local authorities has probably expended itself already; and its real meaning having been thoroughly exposed it is not likely, in any serious shape, to be revived.

In Parliament also the prospects are most encouraging. On the second reading of the Bill last Monday night in the House of Lords not a single voice was raised against it. The unanimity was very striking, not to say astonishing, noble lords responsible for the original Act becoming quite penitential when compelled to speak of its lamentable failure. Some excuses were offered by members of the Government of 1882 for the severity of the restrictions imposed on the infant industry, but they were not such as to redound to the credit either of men of business or of statesmen. The defence, in fact, amounts to this: we have in the past made bad bargains with the undertakers of gas and water supplies; therefore we will make a hard bargain with the undertakers of electric light. But there are

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two people to every bargain; and as men of business the Government might have known that unless both parties were agreed to accept it there would be no bargain at all. And as statesmen, as well as men of business, they might have easily foreseen that any form of agreement which confessedly confiscated the property of one party to the other party would not only be rejected, but on grounds of public policy and morality ought to be rejected. However, the offenders have now—all except one, who has been doing more excellent service by way of reparation elsewhere—acknowledged their error, and what is still better, have promised to amend their ways. So far as can be gathered from what transpired on Monday night, the Bill will meet no formidable obstacle in Committee, and is pretty sure to pass the House of Lords.

As regards the Bill itself, it is fortunate in having Lord THURLOW as its promoter. In other circumstances the choice would not have been a happy one, as Lord THURLOW is chairman of one of the principal Electric Lighting Companies affected by this Bill. But it was extremely desirable that some one thoroughly acquainted with the working of the system, and who could speak authoritatively as to the effect of the Act of 1882, should have charge of its amendment. Moreover, and especially, it is to be noted that the Bill he has introduced is essentially an act of concession; it yields more than has been generally demanded—more, we think, for our part, than the Government have a right to claim; and this being so the fact that a leading body of electric lighting undertakers are prepared to accept the terms which their representative has embodied in a Bill will go far to ensure their acceptance. Nobody can say that he has asked too much in adhering to the forty-two years of life for the provisional order; and his offer to strike out of the Bill all reference to the purchase of the goodwill in order to disarm the opposition of the Board of Trade will in some quarters be thought a great deal too generous. The clause as it stands which repeals Section 27 of the original Act deals with this point as follows:—After a period of forty-two years, or after the expiration of every subsequent period of ten years, the local authority may require the undertakers to sell "upon terms of paying the then market value of the goodwill of the business and of all lands, buildings, works, materials and plant of such undertakers . . . such value in case of difference to be determined by arbitration: provided that the value of such goodwill, lands, buildings, works, materials and plant shall be deemed to be their fair market value at the time of that purchase, due regard being had to the nature and then condition of such buildings, &c., and to the state of repair thereof, and the suitability of the same to the purposes of the undertaking; and where a part only of the undertaking is purchased, to any loss occasioned by severance; but without any addition in respect of compulsory purchase." We have spoken of the Bill, even in its printed form, as a concession; and it will, we think, be admitted that if Lord THURLOW abandons, not merely the customary consideration in respect of compulsory purchase, but the goodwill as well, our description is far from being exaggerated.

But whatever the shape this clause may assume before leaving the Lords, the Bill, as a whole, will go down to the Commons distinctly as a measure of public relief, and will, we believe, be there treated as such. The public have now joined in demanding freedom to use what kind of light they please, and the question is no longer one of the extinction or encouragement of a particular industry. If the electric lighting undertakers had to fight this battle alone they would, it may be feared, obtain scant consideration at the hands of the House of Commons in its present temper. But they have enlisted powerful allies in winning for the electric light the suffrages of the people, or, to put it in language less political, have gained the goodwill of a powerful public opinion. Candles and oil are under no proscription, and from the point of view of social convenience there is no conceivable reason for keeping electric light under a ban. Such of the public as want the light have a right to use it, and the Legislature cannot any longer hinder it either in the interests of the gas corporations or in obedience to socialistic doctrines of confiscation. This being the situation, the Electric Light Amendment Bill, although backed by the head of a powerful electric lighting corporation, will go down to the House of Commons not as a suppliant for favour but as a messenger of peace. If the terms which Lord THURLOW has expressed his willingness to accept find their way to the Lower House and become the law of the land, we can only hope that his sanguine expectations may be gratified. Forty-two years is not a long life for a new enterprise of this kind when we remember that it took twenty-five years to enable the gas industry to work at a profit. The probabilities are against the House of Commons rejecting so liberal an offer, and the unwonted forwardness of business in the House affords additional encouragement to the belief that the abortion of 1882 will be converted into a working Act of Parliament during the present session.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER VIII.—*The Calibration of Current Indicators.*

(Continued from page 439.)

86. The resistance-box is very simply manipulated for altering the amount of resistance in circuit. A vulcanite-

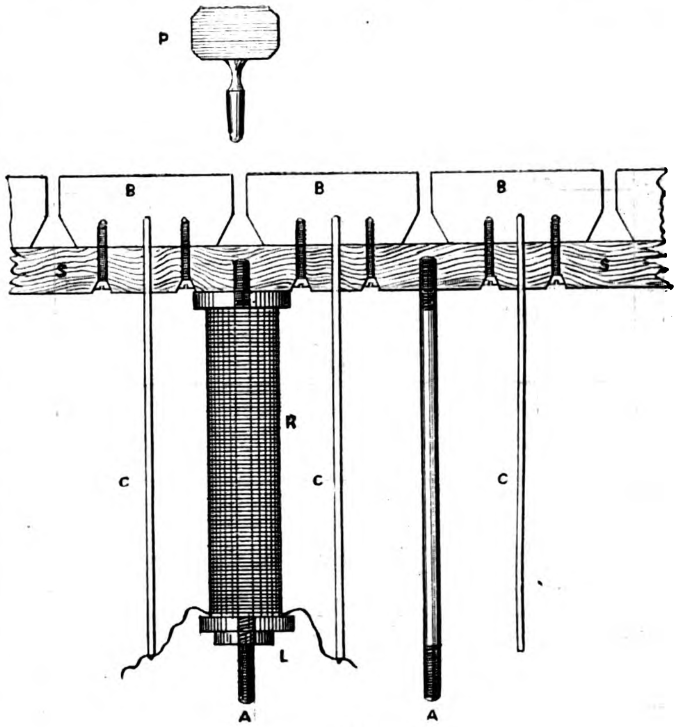

FIG. 51.

headed brass plug P (Fig. 51), when inserted into a round hole between two adjacent brass blocks, B B, short-circuits, or metallically bridges across, the resistance coil R, whose ends are connected to those two blocks. A number of coils wound accurately to different fixed resistances at the temperature *supposed* to be

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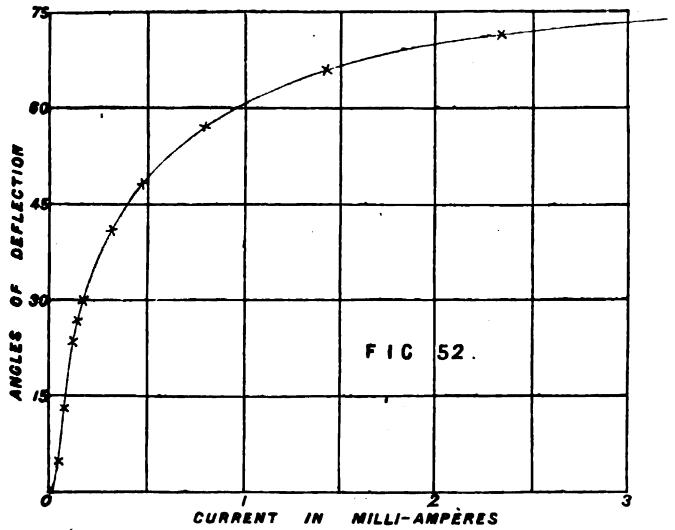
generally prevalent in this climate, viz., 60° F., are contained in the wooden box, the bobbins of the coils being fixed on the under surface of the ebonite slab S S, which forms the lid of the box. These wooden bobbins when wound are slipped over the brass rods A A, which are screw-threaded at each end, serving to screw them into the ebonite slab at one end, and to have a brass lock nut, L, screwed on at the other end after the bobbin is slipped on. The copper wires C C are soldered to their respective brass blocks, and it is to these wires that the ends of the coils are soldered, the final adjustment of the resistance of a coil being made at one of these joints. There are two of these wires to each brass block, so that each coil is attached to its own individual pair of copper wires, and the resistance of each coil can be finally adjusted separately. The wound coils (generally of German silver) are well baked and steeped in hot paraffin wax, melted to above the boiling point, before final adjustment. After this is accomplished the coils are steeped in the same wax, but this time only sufficiently warm to quickly coat them. The resistance of each coil is marked immediately above it on the upper surface of the ebonite slab, and the total resistance introduced into a circuit by means of the box is found by adding together all the marked numbers opposite holes where plugs have been removed. Sixteen coils are generally fitted to a resistance box, which is intended to read up to 10,000 ohms, the resistances of the sixteen coils being of such values that any number of ohms from one to 10,000 can be introduced in the circuit by arranging the plugs.

87. The astatic indicator shown in the figure measured 545 ohms, and gave a deflection of 75° when a resistance of 405 ohms was unplugged in the box, two cells, coupled together *in series*, being employed, each with an E.M.F. of 1·8 volt. With this deflection the current was therefore

$$\frac{(1{\cdot}8 \times 2)\text{ volts}}{(545+405)\text{ ohms}} = \frac{3{\cdot}6}{950} = {\cdot}0038 \text{ ampere}$$

or 3·8 milliamperes.

The deflections were then diminished by increasing the resistance in the box—that is, by unplugging more coils, and



the corresponding deflections for each change of resistance were noted. For facility of calculation afterwards it is advisable to make the unplugged resistances in the box such that when added to the resistance of the indicator a multiple of ten is always obtained. For example an even resistance of 2,000 ohms in the circuit is obtained when 2,000 – 545 = 1,455 ohms is unplugged in the box, and so on. Some eleven or twelve readings were taken in this way, which are shown plotted as a curve in Fig. 52, the currents being calculated as above in milliamperes. If the only cells available were of small plate surface, and therefore high resistance, and could not conveniently be connected together in parallel arc to reduce their resistance, as might be the case with a battery of a number of cells contained in a trough, the resistance of the battery used would have to be added to the other resistances in the circuit in the calculation of the current. One or two ready methods of measuring the resistance of a battery will be considered in a later chapter.

While taking the above calibration test there is no advantage in having a "key" in the circuit, by means of which the latter can be "made" and "broken," since if the circuit is broken after each reading, the needle of the instrument is set swinging inconveniently. The circuit should be permanently connected as in Fig. 50; and it should be observed whether each deflection of the needle remains steady, since if the deflection falls slightly it shows that the battery is polarising, and the readings consequently valueless, because the E.M.F. of the battery is slowly diminishing. This will not be at all likely to occur, however, as the resistance of the instrument is high, and we are adding resistances to it each time a reading is taken. To be sure, however, that no polarisation has occurred, the first reading is repeated, after the whole set have been taken, and if this is precisely the same as at first, it proves that the E.M.F. of the battery has kept constant during the test.

88. With each change in the resistance unplugged in the box the needle will be set swinging slightly, and instead of losing time in waiting for it to come to rest, its oscillations may be checked by a small magnet held in the hand. When the needle swings towards the magnet the latter should present the same pole towards the needle, repulsion between the two like poles checking the swing of the latter. The hand holding the magnet must then be taken right away from the instrument, when the needle swings the other way unless the operator is quick enough to present the other pole of the magnet to the needle on its receding swing. With practice the oscillations can be checked almost immediately in this way, but care must be taken that once the needle is brought to a standstill the little magnet is placed on the table at arm's length away so as not to affect the steady deflections. With even light needles a swing of a very small angle will last a tediously long time, owing to the long fine silk fibre suspension and the inertia of the moving needle, and a lot of time is saved by a little dexterity in checking the swings in the above manner.

(To be continued.)

THE NATIONAL ELECTRIC LIGHT ASSOCIATION OF AMERICA.

CONVENTION AT PITTSBURG.

The meeting of this Association, which was opened at Pittsburg on Tuesday, February 21st, is the seventh occasion on which this important body has been convened. The previous meeting was held in Boston in August last. The following is a brief synopsis of the proceedings at Pittsburg, together with a list of the papers which were read and discussed. Some of these we hope to produce later.

The convention was opened at noon on Tuesday by President J. F. Morrison, who read an able and impressive address on the growth of the association and of the electric lighting industry. He estimated the present figures of electric lighting at 3,000 incandescent and arc isolated plants, and 1,000 central stations, in which were installed or contracted for 175,000 arc lights and 1,750,000 incandescents, being, it was significant to note, in the proportion of 10 to 1. The association had 168 members and $971 in the treasury, with debts of only $98. Mr. Morrison also drew attention to the difference in the growth here and abroad, and said the whole explanation was to be found in vicious legislation.

Major W. C. Moreland, representing the city, then read an address of welcome.

Invitations were extended to the association by the Engineers' Society of Western Pennsylvania to attend its meeting on Tuesday evening. Invitations were also extended from the Westinghouse Machine Works and the Allegheny County Light Company.

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The reports of the secretary and treasurer, summarised in the President's address, were read, and the various sub-committees were appointed.

The following papers were then read :—

"On Electric Light Cables," by Prof. ELIHU THOMSON.

"How can we Protect our Watches against the Influences of Magnetism ?" by Dr. LANGE.

On Wednesday Mr. Arthur Stuart, of the Legal Committee, presented a report with regard to the work on patent legislation done by the committee. After a discussion it was voted to continue the committee, with the proviso that there should be no expense to the Association. A resolution, raising the annual subscription to $20, was carried. The following papers were then read :—

"On Belting," by Mr. C. A. SCHIEREN.

"On Electric Motors," by Dr. LIEBIG.

"On Independent Engines for Incandescent Lighting," by Mr. W. LEE CHURCH.

"On Pressure Records," by Mr. J. B. EDSON.

"On the Relation of Electric Lighting to Insurance," by Mr. S. E. BARTON.

"On Electric Light Carbons," by Mr. W. G. PARKER.

On Thursday Mr. T. C. Smith invited members to see a "lighting-up" from the natural gas stand-pipes of the Philadelphia Company.

The following papers were read :—

"On the Distribution of Electricity by Alternating Currents," by Mr. T. C. SMITH.

"On the Energy of Alternating Currents," by Mr. O. B. SHALLENGER.

"On the Undergrounding of Electric Arc Light Wires," by Mr. W. W. LEGGETT.

After the reading of the papers the President called on Prof. George Forbes to address the meeting. The proceedings concluded with the usual vote of thanks.

ARC LIGHT CARBONS.*

BY G. W. PARKER.

From the standpoint of the manufacturer all well-baked carbons that are straight, free from cracks, and other similar defects, and made from pure material, are good carbons.

The electric light engineer will say that no carbon is good unless it will centre properly and give him a reasonably long life with a good light. He is not at all inquisitive as to the method of their manufacture, provided they give such results.

But as the manufacturer can go no further than to correct any errors in his mechanical processes, the value of the carbon afterwards depends upon the conditions of its use. Such carbons as are described in the first paragraph will with some currents be satisfactory, both as to light and life. In others, the light may be brilliant and the life too short, or there may be arcs too short or too long, flaming or other defects arising from the unsuitability of the carbon to the current, there being no inherent defect in the pencil itself. Therefore, to cover the whole ground of this important inquiry, we should also have the carefully-compiled statements of your experience of the behaviour of carbons burning in your lamps under varying circumstances. From this results of great value to both sides might be obtained.

There appears to be no trouble in determining what constitutes a good carbon mechanically, but to you a good carbon means one that will give you satisfactory results in your use of it ; and there we find several difficulties, without taking into account imperfections in your apparatus. The first is the difference in the strength of the current used in the different systems, and also in many cases in different plants of the same system, the corresponding differences in the resistance of each lamp, and frequently unequal adjustments of lamps in the same plant.

For convenience we are in the habit of referring to those systems in which a small current and a long arc are used as high-tension systems, and those in which a large current and short arc are used as low-tension systems. The requirements of the low tension seem to be a carbon that is hard, well plated, and a good conductor, the latter being the most important. In the high tension, on the contrary, hardness and conductivity seem to be of secondary importance. There is a tendency to flame and burn unsteadily when a hard carbon is used in these systems, and a softer one sometimes becomes necessary, which in many cases shortens the time in which a lamp will burn without being re-trimmed, but in such cases the difference is fully made up in the brilliancy of the light. On the other hand, where a soft carbon is burned in a low tension current, the tendency is to form needle points, which prevent the carbon from centering properly, cause them to heat and is apt to burn the holder.

Let us pursue the inquiry touching the questions of size, conductivity, mortality, and light, and ascertain if definite relations can be established in regard to them that may result in guiding us to the selection of perfect carbons for use from a mass of mechanically good carbons.

Diameters.—It is a matter of great interest to know in what manner and to what extent the size of the carbon affects the result in a current of given strength, covering, of course, in the general question of conductivity, the all-important results of light and life.

Hardness or Conductivity.—It is well known that a hard carbon offers less resistance to the current, or, in other words, has greater conductivity than a soft one ; therefore, in carbons of the same length and diameter, made of the same material, by the same process, conductivity increases and diminishes respectively with their hardness and softness. In either hard or soft carbons, whatever conductivity they possess respectively will be increased or diminished as their diameters is increased or diminished, the length being maintained. It would appear, therefore, that it is possible to make a softer carbon of a larger diameter that will be the equivalent, in conductivity, of a harder carbon of smaller diameter.

Mortality of Carbons.—Of carbons of the same hardness and length, but having different diameters, the larger will undoubtedly outlive the smaller. Of carbons of the same diameter and length, but differing in hardness, the harder will outlive the softer. Therefore a carbon of larger diameter which is soft may be equivalent to a smaller carbon which is hard, as to life, just as it has been shown to be equivalent in conductivity. The life of a carbon is of course dependent upon many vicissitudes, such as high winds, broken globes, &c. ; but under the same conditions the statement made above is undoubtedly a fact.

Brilliancy of Light.—It is well known and admitted that as between hard and soft carbons of the same diameter the latter will give a more brilliant light. It is just as well known that in case of hard carbons those of smaller diameter will within certain limits give a more brilliant light than those of a larger diameter. On the above statement of facts it may be regarded as settled, then, that with the same diameter, but differing in hardness, the hard carbon will possess greater conductivity and have a longer life, but with less brilliancy of light ; while the softer carbon will have less conductivity and a shorter life, with a more brilliant light. And further, that with uniform hardness, but differing in diameter, the larger diameter will have the greater conductivity and longer life, with a less brilliant light, while the smaller diameter will have less conductivity and a shorter life, with a more brilliant light.

The foregoing statements indicate invariably that with greater conductivity light diminishes and life increases ; and, conversely, that with diminished conductivity the brilliancy of the light is increased and the life shortened. In corroboration of this it appears that a small, hard carbon is practically the equivalent of a larger, soft carbon, their conductivity being also equivalent.

Heretofore, it has been considered probable that the diameter, candle-power, resistance per lamp, conductivity of the carbon point and strength of current are all interdependent, and a change in any of them will affect all the others, requiring a counteracting change or adjustment in some of them in order to restore the proper relations between them. This, if so, you can readily see is difficult to do, for part of the work is to be done by the manufacturer and the remainder is under your control.

On the other hand, if the deduction can be properly made from the statements herein presented, that the resistance of the carbon point will determine its capability in respect to light and life in the different currents, the trouble is practically removed. It is not impossible, I think, to construct a machine that will, at no great increase of cost, assort the carbons into groups of uniform resistance or conductivity. Then, with constant currents, clean lamps, perfect connections and insulation, you will ascertain practically that carbons mechanically good will prove to be good and uniformly so in actual service.

Much more could be written upon this interesting question, but this paper is already too long. I have noted for your discussion some important points which I hope your experience will enable you to determine definitely if they are well taken or not. I would be glad to have the whole question of the imperfect burning of carbon points thoroughly canvassed, so that manufacturers would get some hints as to what may be done by them in the way of correction when the fault lies at their door. It is especially desirable to be informed if that very disagreeable feature in the burning of carbons called "flaming" is always the effect of one particular cause, and what that cause is.

* Read at Pittsburgh, Feb. 22, 1888.

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REVIEWS.

Munro and Jamieson's Pocket Book of Electrical Rules and Tables. Fifth edition. (London: Charles Griffin and Co.)

We gladly welcome the fifth edition of this indispensable little book, which is by this time far too well known to electricians to need any recommendation from us. The present edition has been further revised, and has received some important additions. The section relating to secondary batteries is now very complete, and we hope that in the next edition some space will be given to transformers, a subject which is at present altogether omitted.

Journal of the Society of Telegraph-Engineers and Electricians. No. 70. (London: E. and F. N. Spon.)

The present issue of the *Journal* is of special interest, as it contains the inaugural address of Mr. Edward Graves on assuming the presidential chair. This is followed by Mr. A. C. Cockburn's paper "On Safety Fuses for Electric Light Circuits, and the Behaviour of the various Metals usually Employed in their Construction." An important discussion followed the reading of the paper, which is here fully reported. At the same meeting Mr. A. Paris's Hydrophone was exhibited and described by Mr. W. H. Burns. The rest of the *Journal* is taken up, as usual, by abstracts and translations, chiefly from the French and German technical press, and we need scarcely add that these are also, as usual, well selected and well edited.

LONG-DISTANCE TELEPHONY.—THE INFLUENCE OF SELF-INDUCTION.*

As the author says at the end of his article, the formulæ with which it abounds are not very simple, and it will be impossible within the limits of an abstract to do more than glance at some of the conclusions drawn from the mathematical reasoning.

The three points raised are—

1st. What is the greatest distance over which conversation can be carried on for a certain kind of line?

2nd. What effect have submarine or subterranean sections on the air-line?

3rd. What sized wire should be adopted?

Preece has shown that the greatest distance at which speech is audible is equal to the square root of the fraction whose numerator is a constant depending on the nature of the line, and whose denominator is the product of the capacity and resistance. This formula takes no account of two very important factors, viz., the insulation of the line and its self-induction. Both these factors are duly taken into account in the author's calculations. He expected that the self-induction would have the effect of reducing the current, and thereby of weakening the sounds transmitted. He was therefore very much surprised, on applying his formulæ to the case of a copper air-line some hundreds of kilometres long, to find that the injurious effect of the electrostatic capacity, far from being increased by the self-induction, was in a great measure counteracted, and that the transmission was improved.

To show clearly the important part taken by self-induction, and how inexact is any rule for finding the limit of hearing from the product of the capacity by the resistance, the author gives the following results to which the theory leads:—

The self-induction has the effect of considerably increasing the current on arrival above the value which it ought to have according to Sir W. Thomson's theory.†

In those cases where Thomson's theory shows very unequal weakenings of sounds of different pitch, and consequently considerable alteration in the tone of a complex sound, the self-induction largely prevents this change, and alters completely the character of the transmission.

If the ratio of the self-induction to the resistance—which depends on the nature of the line, and not on its length—goes beyond a certain limit which seems to be reached for copper wires of 4·5 mm. diameter, the tone is not sensibly affected, even when the line is very long. Supposing the self-induction nil, it would be found, on the contrary, that the line deadens the sharp sounds and only transmits the low notes.

Taking as a special case a line of 1,200 to 1,500 kilometres, consisting of two copper wires 4·5 mm. in diameter, fixed about 1½ metres apart, it is found that the strength of the current on its arrival is greater than it would be on a local circuit of the same resistance, but having neither capacity nor self-induction.

A condenser or an electro-magnet inserted singly in a circuit will diminish the current; but if both are inserted in series in the same circuit they correct the reciprocal injurious effects—at least partially.

The greater the self-induction, the more, supposing the E.M.F. equal, the electric undulations will be reduced, but the more regular will be their propagation. If the self-induction is large—or, rather, if the ratio of self-induction divided by resistance to the time of vibration is large—the speed of propagation will be sensibly uniform, and the alteration of the undulations will be small in spite of the resistance. From this point of view, therefore, it is desirable to increase the self-induction or to diminish the resistance.

The effect of leakage on the line is to add to the injurious effect of the factor capacity multiplied by resistance another term, viz., the self-induction divided by the insulation resistance; and to introduce an entirely new term depending on the resistance of the line, the insulation, and difference of potential between two points of the line.

The current arriving at either station is so much the weaker, other things being equal, the nearer the leakage is to the centre of the line. An underground or submarine section on the line is more injurious when it is near the middle of the line than when its position is towards either of the two ends.

* From the Abstracts in the *Journal* of the Society of Telegraph-Engineers and Electricians, No. 70. Abstract from a paper by M. Vaschy, *La Lumière Electrique*, Vol. XXV., No. 27, pp. 18–22; No. 30, pp. 165–70; No. 32, pp. 264–70, 1887.

† For "Sir William Thomson's theory," we take it that we should read "Sir William Thomson's formulæ" for the speed of signalling on submarine cables.—Ed. *E.*

M. JABLOCHKOFF'S TRANSFORMERS.

It is not generally known—at least, it has only recently come to our own knowledge—that M. Jablochkoff had the idea of using a

Fig. 1

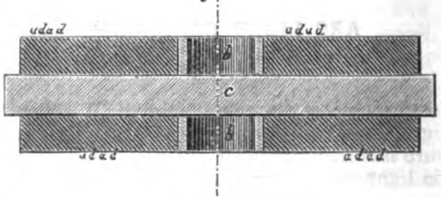
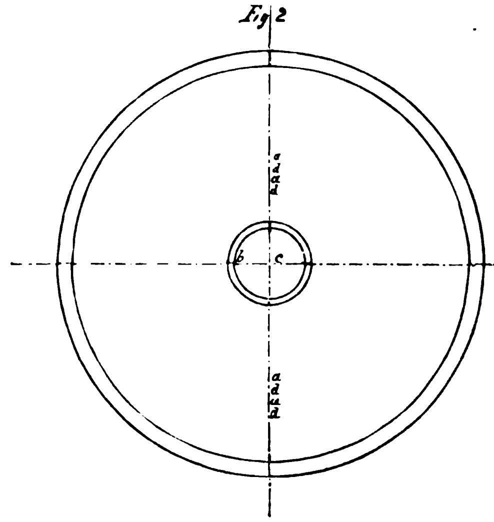


Fig. 2



closed magnetic circuit transformer with alternating currents as long ago as 1877. In a patent of that year, describing a method of distribution primarily for use with Jablochkoff lamps, but available also for other purposes, the following passage occurs:—

"In cases where continuous electric currents are employed the induction coils are provided with interruptors and condensers, either one to each or one to a number of coils. In the case of alternating currents the interruptors and condensers are dispensed with, the coils employed being constructed similar to the form of electro-magnets for which prior letters patent, No. 836, of 1876 have been granted to me."

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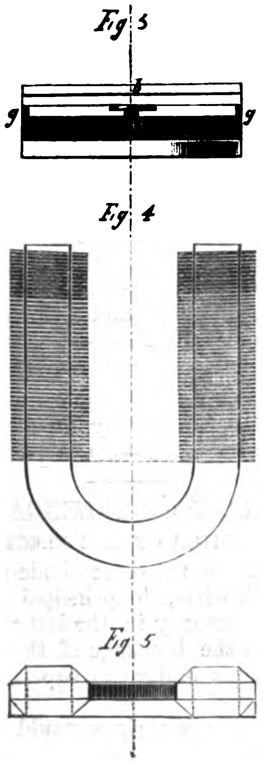
The following is an extract from the specification alluded to :—

"Fig. 1 is a vertical section and Fig. 2 a plan of a disc electro-magnet according to my invention. A barrel or strip, *a*, of copper or other suitable conducting metal, along with a strip, *d*, of paper, cardboard, or other non-conducting material, is wound spirally round a core, *b*, of wood or other non-conducting material, so that the edge of the conducting band or strip rests against the face of the disc *c*, each convolution of *a* being separated from the next by the non-conducting band *d*, which is wound along with it. A similar arrangement may be applied to the opposite side of the disc *c*, as shown in Fig. 1. As an electro-magnet is thus produced, having one pole at the centre of the disc and the other at the circumference, *I complete the magnetic circuit*, and apply an armature in the manner shown in Fig. 3, which represents a section of a disc magnet, having the coil on one side. A central stud, *f*, and an outer ring, *g*, form respectively polar extensions to which an armature, *h*, can be applied. The disc, instead of being circular, might be of square or polygonal form, the coil being wound on a core, *b*, of suitable form ; also the surface of the disc might be concave or convex, and the metal coil might be wound without making absolute contact with the surface of the disc.

"Fig. 4 is an elevation of a horseshoe magnet, coiled with a helical band or strip. When the iron horseshoe core is of rectangular section, as shown in the plan Fig. 5, the strip can be wound round it by folding it over at the angles."



The remarkable thing in this description is the use in the year 1876 of the phrase "I complete the magnetic circuit," especially in connection with the subsequent statement that this type of magnet is applicable for alternate-current transformers. We have, however, been unable to discover that M. Jablochkoff ever actually constructed such a transformer as is here described. We have, in fact, some reason to believe the contrary.

It will be remembered that the Jablochkoff patents have been acquired by the United Electrical Engineering Company, Limited.

CORRESPONDENCE.

THE WEST INDIA CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Your New York correspondent, in his letter published in your issue of March 2nd, is hardly fair to the West India and Panama Telegraph Company.

It is well known on this side that the company has struggled heroically for many years past to maintain telegraphic communication with and between the West India Islands under most serious disadvantages.

No dividend whatever has been paid upon the ordinary shares for a number of years, and nearly all the earnings have been devoted to the maintenance of the lines. The subsidies received are quite inadequate, and, notwithstanding frequent and energetic representations, the Imperial Government, I believe, give no subsidy whatever.

On the Board are some of the most experienced cable and telegraphic authorities in the world. It is only necessary to mention such names as those of Sir James Anderson, Mr. C. W. Earle, Mr. H. Weaver, and Mr. W. Andrews, to show that the management of the company is in thoroughly competent hands.

Of course, the remarks in question may be meant as a reflection upon the British Government for neglecting to support lines which are of such importance to the Colonies and the mother country ; and if so those criticisms do not apply.

Considering the very insignificant part the United States have played in cable-laying, and the fact that practically submarine telegraphy is the result of the private enterprise of this country and the energy and foresight of such men as Sir John Pender, it is rather amusing to be told that "if the United States owned the West Indies the cable service would be a great deal better than it is."—Yours, &c.,

London, March 5th, 1888. G. N. R.

EFFICIENCY OF INCANDESCENT LAMPS; AND ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : In the very interesting and complete report on page 454 of your issue for 2nd March, of the communication made by Prof. Perry and myself, "On the Efficiency of Incandescent Lamps with Direct and Alternating Currents," to the Physical Society, on the 25th February, there is a misconception which, as it involves a question of principle, and not a mere matter of detail, I should like to correct. The expression for the true watts given to the circuit is correctly stated in your report as

$$\frac{r\tau\sqrt{V^2 . A^2}}{\sqrt{L^2\pi^2 + r^2\tau^2}}$$

but A and V are not "the mean value of the potential in volts, A that of the current in amperes," but the square roots of the mean squares, which differ by 10 per cent. from the mean values when the P.D. and the current are sine functions of the time. The figure correctly represents the apparatus employed in the investigation, but it is inconsistent with the statement in the report that "r is the resistance of the dynamometer, and L its coefficient of self-induction." r and L refer to the lamp only, and therefore L was practically negligible, so that the product of the square root of the mean square of the volts into the square root of the mean square of the amperes correctly measured the power given to the lamp.

The numbers 3·3989 for direct currents and 3·3955 for alternate currents are the watts per candle, and not, as stated, "the light obtained from the lamp in terms of the standard candle for the power of one watt."

I should like to take this opportunity of thanking Messrs. Shepherd and Wheatley, two of the students at the Central Institution, for their assistance in conducting the investigation.

While writing this my eye has caught Mr. Pollak's question in his letter, in the same issue of your journal, on a totally different subject—viz., "Electric Traction." I may therefore mention that the magnetic device of ours for use in working long electric railways with little leakage, to which Mr. Geipel was, I presume, alluding, is referred to on page 15 of our patent, No. 783, dated 1881, for "Electrical Conductors," and which therefore antedates that of Messrs. Pollak and Binswanger by *five* years. Regarding Mr. Pollak's statement, "As I know Profs. Ayrton and Perry before this date (1886) had not proposed tramways on the parallel system, &c.," I must ask him to kindly refer to my lectures delivered some years before that date on electric railways worked on the *parallel* system at the Royal Institution, London ; the Royal Society, Dublin ; the Birmingham and Midland Institute, &c., which were not only reported and illustrated at the time in your own and other scientific periodicals, but also in the *Graphic* and other newspapers of general interest.—Yours, &c.,

W. E. AYRTON.

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ELECTRIC TRACTION.—CLOSED CONDUIT SYSTEMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Charles Pollak asks me to point out dates and papers in connection with *the system of making contact by magnetic attraction* invented by Profs. Ayrton and Perry.

I find the patent specification which contains the improvement to which I refer is dated 24th February, 1881, No. 783—that is, two years prior to the specification alluded to by Mr. Pollak; although in writing my paper I did not look up any such matter, but merely wrote the impressions I had formed on the subject from various sources.

I have read over, however, Ayrton and Perry's patent No. 783, 1881, from which I extract the two following paragraphs:—

"Our improved apparatus consists of an insulated wire cable, or other conductor or conductors, placed either alongside, above, or underneath the railway, or in any other suitable position, and the insulation of which is maintained by gutta percha, india rubber, &c., or by paraffin or other oils, or by its being supported on insulators. This conductor, or conductors, is automatically, or at will by a signalman or other person, electrically connected successively to one or more sections of a rail in the neighbourhood of the moving train. This rail, which may or may not be that on which the train runs, and which may be rigid or somewhat elastic, is divided into sections fairly well insulated from one another and from the earth by the methods described further on. Since then leakage to the earth of the current which propels the train can only take place from that section or sections of the rail which are at any moment electrically connected with the continuous insulated conductor; the loss of power by leakage of electricity to the ground will be very much less than in the case of a single imperfectly insulated rail, such as has been hitherto employed for electric railways, and which if of considerable length, with its corresponding large number of points of support, would possess a very large number of points at which leakage of the motive electric current would continually take place."

"Instead of mechanical plungers, shown on sheet 2, for automatically connecting the main cable with the section just entered by the train, and for automatically disconnecting the main cable from the section the train is leaving, we may use electric means for this purpose, ... or we may employ a magnetic arrangement, depending for its action not on the weight of the train but on its magnetic mass."

In conclusion, I must say that I fail to see how any distinction can be made in the application of this system, viz., the making contact by magnetic attraction on the *series* or *parallel* system; the object of the improvement is evidently to overcome the difficulty of leakage in long lines.

As to the validity of the several patents, it is for others than myself to pronounce.—Yours, &c., W. GEIPEL.

Edinburgh, March 5, 1888.

ON THE MEASUREMENT OF MAGNETIC LAG.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following is the method of procedure to find the lag of magnetisation behind the field produced by the currents, in the case of secondary generators, to which I alluded the other evening at the meeting of the Society of Telegraph-Engineers and Electricians in the discussion following the paper by Mr. Kapp upon secondary generators.

To keep the formula quite general I will suppose that three dynamometers of different constants, A, B, C, are used, and I shall refer to each dynamometer by these letters, as 'the dynamometer A,' it being understood that if the current through the dynamometer A is I, while the reading is a_1, then $\frac{I^2}{2} = A a^1$.

Dynamometer A is placed in the primary circuit, and its reading is a_1.

Dynamometer B is placed in the secondary circuit, and its reading is a_2.

Dynamometer C has one coil in the primary circuit and the other coil in the secondary. Its reading is a_3.

The three observations are made simultaneously.

m and n are the number of turns in the primary and secondary coils respectively.

Then the angle of magnetic lag θ is given by the equation,

$$\tan\theta = \frac{C a_3 - \frac{n}{m} B a_2}{\sqrt{A B a_1 a_2 - C^2 a_3^2}}.$$

If the dynamometers are all similar $A = B = C$, and if the number of turns in the primary coil is equal to the number of turns in the secondary coil $m = n$

In this case

$$\tan\theta = \frac{a_3 - a_2}{\sqrt{a_1 a_2 - a_3^2}}.$$

It will be observed that the numerators only involve the observations on two of the instruments; thus, only these two dynamometers are necessary to determine whether or not the lag exists; for if it does not exist, these numerators vanish.

The tangent of the angle of lag is proportional to double the hysteresis coefficient, or to the coefficient of magnetic self-induction, the induced field being proportional to the rate at which the magnetisation is changing, and therefore having its phases in quadrature with the magnetisation itself.—Yours, &c., THOMAS H. BLAKESLEY.

Royal Naval College, Greenwich, March 6, 1888.

INDUCTANCE AND RESISTANCE IN TELEPHONE CIRCUITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In answer to your correspondent F. B. Hawes, who writes under the above title in the March 2nd number of your journal, p. 452, I am sorry to be unable to do more at present than to refer him to the note at the end of Section XLVII. of "Electromagnetic Induction and its Propagation," in *The Electrician* for December 30, 1887.—Yours, &c.,

March 3, 1888. OLIVER HEAVISIDE.

[We may also refer our correspondent to an important paper on the same subject by M. Vaschy, an abstract of which will be found in our present issue.—ED. *E.*]

THE STABILITY OF TELEGRAPH WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With respect to the correspondence on the subject of springs for telegraph wires, the principal failures in the case of the wires of this company in the last snowstorm (January, 1887) arose not from the breakage of the wires, but from the collapse of the supports under the superincumbent weight of snow.

I fail to see in what way springs would relieve the supports of this extra burthen.

An increase of the dip would somewhat increase the length of the span and the snow-carrying length of the wire; the strains on a straight line are, of course, balanced at the insulators, and if the wires are strong enough, as in many cases they are, to carry away the supports when steadily loaded up to their utmost capacity, nothing short of removal of the load of snow will reduce the weight to be carried.

The real difficulty is not to prevent the wire breaking but the supports from giving way, and it should not be forgotten that, except in the case of terminal insulators, there is no strain whatever on the poles on a straight line, but only the weight of the wire and its burthen to support.

Even in the case of a lateral strain being added, as in the case of wind, the strains are still balanced at the insulator, and the stress on the support is only that due to the surface pressure of the wind acting on the wire as a sail.—Yours, &c.,

F. HIGGINS.

17 and 18, Cornhill, London, E.C., March 5, 1888.

THE STABILITY OF TELEGRAPH WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Preece compliments the advance of my education on the above subject, but I think your readers will see that I have not changed the ground I occupied when I first wrote you (see *The Electrician*, 21st October, 1887). Meanwhile Mr. Preece has been making giant strides himself. He recognises

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at last that the elasticity of the wire must be allowed for: and he does not offer one word in corroboration of the table of dips and stresses which he upheld at the British Association only seven months ago.

But Mr. Preece is really too flattering when he calmly assures your readers that I have "calculated a certain curve, and *caused my apparatus to reproduce it!*" Your readers know quite well, without his telling, that I calculated the curve, and that my calculation, unlike his own, proved substantially correct. But that I worked the miracle of making the curve suit my calculation would make a wizard of me, when, as Mr. Preece (apparently at a loss for better argument) very properly shows, I am not entitled even to rank as a telegraph engineer!

Then Mr Preece adds, "his data are wrong, his curves are wrong, and he is working in the dark." It is a pity to spoil this rhetoric, but if Mr. Preece will come to Sunderland, I will repeat the experiments in his presence, and prove to him in broad daylight that the curves are right and the data right.

If he will not come, then let him issue figures of his own, and if they differ substantially from mine I will undertake that they shall share the fate of the Manchester table of dips and stresses. By the way, how came that table to be put forth, *if* (as Mr. Preece states) "responsible engineers had performed more than a quarter century ago similar experiments," which should have prevented Mr. Preece from neglecting to allow for the stretch of the wire?

Mr. Preece does not condescend to enlighten your readers as to the nature and extent of the "errors" which he alleges I have committed in my experiments; but he axiomatically says, "A telegraph wire is freely suspended between two rigidly fixed points;" as if anybody would dream of disputing what everyone knows. And he oracularly adds, "We have to regard what takes place in only one span;" which is precisely what we did regard in the Monkwearmouth experiments. Then he says, "Omitting external stresses, the changes of form in this span are changes due to variations of temperature. The changes of strain are changes due to its own elasticity," which not very original observation it is not for *me* to dispute. Although these axioms have no proper bearing on the experiments I have published, I may as well point out that change of form in a span of wire is *not* due alone to variations of temperature, but is due also to elasticity. Likewise, changes of stress are not due alone to elasticity, but also to expansion. Expansion and elasticity are the *component* contrary working forces whose *resultant* is the change, both in form and stress, of the wire. Thus Mr. Preece's *axioms* will not hold water any better than his *table*.

Mr. Preece suggests that I erect a span of wires and watch "their vagaries" for years. Happily I am spared this necessity, for a long span of many telephone wires passes within a stone's throw of my parlour window, and I have for more than four years had the opportunity of studying the same; even now, as I write, a strong gale is whistling through the wires. Mr. Preece also advises me to experiment on the breaking strength of wires. This I have done, and have come to understand, at least to some extent, the relations between the limit of tenacity and the limit of elasticity, and the important bearing of these relations on the life and duty of the wire.

If, by increasing the tensile strength of the wire and frequency of posts, the conductivity and *insulation* are improved without considerable increase of first cost and maintenance, then Mr. Preece may go on making erroneous tables and "smiling at springs" with impunity.

But if, on the other hand, by means of this officially approved innovation the cost be increased and the insulation lessened, the intelligent taxpayer will fail to see where the smile comes in.

Mr. Preece has sufficiently proved that he is not incapable of living and learning, and his last letter is so pregnant of "changes of strain due to elasticity" that I think, if he will only allow his mind free play, he will arrive at conclusions, regarding the saving power of springs against stresses from ice, snow, wind, falling trees, &c., which will enable him to agree with the truth I have from the outset endeavoured to demonstrate, and especially in my unanswered letter and diagram with tables (*The Electrician*, 9th Dec., 1887).

Then he will regard the springs with a "smile" of intelligent welcome rather than of prejudiced derision.

Mr. Bozon's new bull about my having, as he supposes, "forgotten to allow for the spring balance and vice," is not less amusing than his memorable buffers of imperishable rubber. His mistake is really too childish for me to occupy your space in explaining; but if he will send me his private address, I shall be pleased to do my best to put him right on the point.—Yours, &c., FRANK CAWS.

Sunderland.

THE TERM "MAGNETIC RESISTANCE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: First, I did not mean to say that M. Hospitalier put μ in the numerator in his "magnetic resistance;" μ was a slip for $1/\mu$. I noticed the error when the letter was printed, but thought it too obvious to require correction. To make sure there is no misunderstanding, let me say definitely that by "magnetic resistance" I presume is meant the total "magnetomotive force" divided by the total induction. In a closed circuit transformer this would be $0{\cdot}4\pi$ times the magnetising ampere turns divided by the total induction.

Having shown, I hope, that I have not misunderstood M. Hospitalier, let me say I fear he has misunderstood me in some way. I said nothing about electrostatic resistance, and do not see that its being of the nature of a slowness is to the point.

A digression which has nothing to do with M. Hospitalier may be allowed. Some two years ago I pointed out that it is nonsense to speak of resistance in the electrostatic system as of the nature of a slowness. It has nothing to do with slowness. The idea arises from want of clearness as to the physical meaning of $\frac{[T]}{[L]}$. The symbol $\frac{[T]}{[L]}$ simply shows what number the number of units representing a slowness or a resistance in the electrostatic system must be multiplied by if the fundamental units are changed. It has nothing to do with the nature of resistance. For instance, resistance is of the same nature whether it is measured in electrostatic or electro-magnetic units; the only difference is in the units, one of which is v^2 times as large as the other. When I wrote on this subject before I found that many thought I was talking nonsense, because no one could suppose that resistance was velocity; others said that $\frac{[L]}{[T]}$ meant that resistance, in electro-magnetic measure, is measured by a velocity or by velocity. This also means nothing, as the slider arrangement always used as an illustration can be equally well used to show that the current or the electromotive force varies as the velocity.

That there is much mental confusion on these points is obvious from the unintelligent way the "dimensions" are copied into text-books. It is hardly likely that Maxwell, who wrote as a physicist more than as a mathematician, did not keep the physical interpretation before him; but the fact remains that he gives [0] as the change ratio of such quantities as specific electric, and magnetic inductive capacity, and this has been blindly copied, I think, by every English text-book.

Returning to M. Hospitalier's letter, I am afraid the *lettres de ronde* will be often confused with German capitals. For instance, in my letter I particularly desired the printer to use German capitals, and he used *lettres de ronde*. As to the vector question, it is, of course, of little importance; but it is worth while calling attention to it. These German capitals have the disadvantage that one cannot tell what letters they represent without frequent reference to a dictionary. A suggestion, due to Dr. Fleming, is to use thick or block letters for vectors. Why not use these instead of Maxwell's when they are to represent quantities not considered as vectors? Of course, *lettres de ronde* will do as well if they are a fount in universal use.

I have written at some length, not with the wish to be too critical, but because M. Hospitalier is likely to do more for a universal notation than all the rest of us together, and so it is of the highest importance that he should start fair, and I feel sure he will himself invite criticisms and opinions. In England,

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Maxwell is looked upon as the chief text-book, and it is to be feared that if M. Hospitalier departs from Maxwell's ideas and notation it will prejudice the introduction of his own.—Yours, &c., JAS. SWINBURNE.

BATTERY *VERSUS* ALTERNATE-CURRENT TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I for one shared the disappointment of which you speak in your last week's leader at not hearing from Mr. Crompton something more definite as to the cost of lighting on the battery system. At the previous meeting Mr. Crompton challenged the other side to produce actual figures showing the cost of distribution by transformers, and he said he was prepared to go into the fullest details upon the basis of his own experience with batteries. It is to be hoped that Mr. Crompton will still take an early opportunity of giving us the facts as to first and prime cost (including renewal of batteries) in some well-known installation, say, for instance, the Vienna Opera House, which he referred to at the meeting. Meanwhile, in common with most other electricians of my acquaintance, I find it very hard to believe that the system of low-tension distribution, plus batteries, whose depreciation rate is still an unknown quantity, while their first cost is enormous, can possibly compete in point of economy with a system in which the life of the transformer may easily be twenty times as prolonged as that of any known battery, and in which the cost of distributing mains and transformers together is but a fraction in comparison with that of a battery system. It is for Mr. Crompton to prove the contrary—if he can.—Yours, &c., C. W. S. CRAWLEY.

Castletown-road, West Kensington, March 8, 1888.

TELEPHONIC COMMUNICATION WITH SHIPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your remarks about telephonic communication with ships at anchor in your issue of Dec. 23, 1887, it might possibly interest you to learn that we established such communication with the ships of the Orient and Messageries lines, now nearly two years ago, and that it has been working well ever since with rare exceptions.

I enclose an extract from the *South Australian Advertiser* of March 30, 1886, and shall be glad to furnish you with description and sketches of arrangements if you deem it desirable.—Yours, &c., C. UNBEHAUN, Telegraph Department,

Adelaide, Feb. 6, 1888. Adelaide, S.A.

[We should be glad to receive the description and sketches from our correspondent. The extract referred to will be found amongst our "Notes."—ED. *E.*]

THE INDUCTOR DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I see in your last issue in the report of the discussion of Mr. Mackenzie's paper at the Society of Telegraph-Engineers that Mr. Esson prophesies that the magnets of my dynamo will get hot. Will you allow me to allay his anxiety on this point? In the machine partly constructed and now under trial, both the inductors and the magnet cores, being thoroughly laminated, remain quite cool.

The field, or primary magnetism, is slightly unsteady, but no bad effects are perceptible from this cause. It is, of course, easy to make the magnetism quite steady by properly proportioning the inductors.—Yours, &c., J. A. KINGDON.

Kidsgrove, March 6th, 1888.

REINBOLD'S ALUMINIUM PROCESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your correspondent, who asks for information in reference to Mr. Herman Reinbold's process for the electro-deposition of aluminium, a notice of which appeared in your paper of the 3rd ult., I may say that it strikes me that the formula given is a somewhat remarkable one, and in the hands of inexperienced persons might involve very serious consequences.

According to the recipe 50 parts of alum are dissolved in 300 parts of water and 10 parts of chloride of aluminium added, the whole being heated to 200 degrees and allowed to cool, whereupon 39 parts of cyanide of potassium are to be added. Now, if it be the anhydrous chloride of aluminium that is to be employed, this would at once be decomposed by the water, with formation of alumina and liberation of hydrochloric acid; or if the hydrated chloride were used, this would be in a highly acid condition. To this acid mixture we are to add 39 parts of cyanide of potassium, which it is evident would be immediately decomposed by the hydrochloric acid and the alum, hydrate of alumina being precipitated and hydrocyanic acid set free in abundance. How such a process is to act I am at a loss to conceive. Cyanide of potassium in the presence of an acid solution like that of alum, would be risky enough if the operations were conducted under the nose of the operator, but with free hydrochloric acid also in the liquid even a very small experiment would be dangerous in the hands of persons unacquainted with the deadly nature of cyanogen vapours. Since the combination given in the formula would undoubtedly result in the precipitation of the whole of the alumin, the deposition of metallic aluminium from such a mixture would, I should say, be an impossibility.—Yours, &c, ALEXANDER WATT.

THE ELECTRIC LIGHTING ACT (1882) AMENDMENT BILL.

In the House of Lords on Monday, March 5, LORD THURLOW, in moving the second reading of this Bill, said that if he could have had an assurance from the Government that they would be willing to take this matter in hand, he would not have troubled their lordships on the present occasion. He desired their lordships to regard this question from the point of view of health, of science, of more light, of safety, and of the preservation of property. The object of the Bill was to remove what had proved to be prohibitive restrictions upon an industry which was deserving of every support. The restrictions imposed by the Act of 1882 had acted very harshly. The President of the Board of Trade, replying last week to a question in the House of Commons, said that since the passing of the Electric Lighting Act of 1882, fifty-nine provisional orders and five licenses had been granted to companies, and fifteen provisional orders and two licenses to local authorities. The President of the Board of Trade was not aware that in any single case where these powers had been obtained they had been exercised. Such was the crushing effect of the Electric Lighting Act of 1882. Still he wished to say a few words in praise of that measure, which it was the object of this Bill to amend in only one or two small but important particulars. The Act of 1882 was a most elaborate measure for dealing with a then almost unknown science. It successfully prescribed safeguards against dangers which had only since become manifest, and its object was to impose checks on rash and ill-considered schemes. It now only required trifling amendment to allow the industry to proceed, and he claimed that the time had arrived for action in that direction. In the United States there were over 120 electric light companies paying dividends from 6 to 14 per cent., in Germany there were 604 companies, and in almost every large town in Italy electric lighting was making progress. It was only in England that the science was comparatively at a standstill, and he hoped that state of things would not be allowed to last much longer. The present time was propitious for several reasons. There never was a time when a larger amount of capital was lying idle or when there was a larger number of unemployed seeking work and finding none. Many of their lordships had no doubt visited factories lighted by gas full of toiling men, women, and children from 6:30 a.m. to 6:30 p.m., and had noticed the vitiated state of the atmosphere. The difference between that and a factory lighted by electricity was manifest in a moment. It was like being transported suddenly to another planet. Workmen who had been employed in factories lighted with electricity had told him that nothing short of starvation would induce them to work again in factories lighted by gas. It was the same in the case of mines. Electric lighting would minimise the dangers which now occurred through naked lights or faulty lamps. Then as to fires in the metropolis, Captain Shaw's report showed that the total number of fires in 1887 was 2,363, and no less than 671, or 30 per cent., were directly attributable to causes connected with existing systems of lighting. These figures did not include 691 fires the origin of which was uncertain, and of these at least 30 per cent. might fairly be said to be due to the same cause. Then as to the destruction and damage to property. Some of the first tradesmen in London had told him that they had effected great saving since they had substituted the electric light

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for gas in their show rooms and shops. It was also well known that the use of gas was very prejudicial to books, and the employment of electric light in libraries would be a great advantage. The Bill was precisely similar to the Bill which was passed by this House last Session, and it proposed to extend the license granted by provisional order to any company from 21 years to 42 years. The period of 21 years fixed by the present Act was found to be too short and to be insufficient to allow electric lighting companies to recoup themselves. The Board of Trade acceded to this view, and this extension of the life of the provisional order would render the clauses with regard to the terms of purchase of less importance. He would therefore be willing to strike out of the Bill all reference to the purchase of "the goodwill," which he understood had hitherto been a stumbling block and a cause of opposition to the Bill. In bringing forward this measure he was solely actuated by a desire for the public interest. There existed at present a great want of employment, and yet, as was well known, there was a vast amount of capital waiting for investment. If the present Act was amended as this Bill proposed, he believed that £100,000,000 of capital would thereby find useful employment (hear, hear).

The DUKE OF MARLBOROUGH said the Bill did not appear to contain any regulations as to the laying down of the electric cables. At present these lines were growing in number and were being run over everybody's houses without the assent or consent of householders, and he thought that it should be defined in any Bill dealing with this subject what the rights of electric companies exactly were. There had, so far as he knew, been no decision in the law courts upon the point. At present a quantity of telephone wires were to be seen running in every direction in the metropolis. The cables for electric lighting would be still more dangerous. They would in time become a great nuisance, and if the Acts dealing with electric lighting were silent on the point it would hereafter be said that Parliament had unreservedly conferred on these companies the right of running these cables over houses as at present.

The EARL OF CRAWFORD and BALCARRES agreed that the Electric Lighting Act required amendment, but he thought they should deal in a thorough manner with this subject and not merely with a single clause. In 1882, when the first Act was passed, a determination was formed that the promoters of electric lighting schemes should not enjoy a monopoly, and it was accordingly resolved that when cables were laid in the streets of any town by an electric company its work should be purchaseable by the local authority. Another provision of the Act laid down that no work should be undertaken by a company without a license from the Board of Trade, or a special Act, or a provisional order. These two provisions had been fatal to the measure, Licenses and provisional orders had been applied for, but no work had been done. He suggested that the promoters of a scheme ought to be allowed to make their own arrangements with the local authority. Let the company pay rent for the use of the mains which they placed under the streets, and let them be absolved from the obligation of supplying light to every corner of a given district when there might be no chance of a reasonable return for their outlay. He looked forward to the day when companies would be able to lay their cables underground with a good prospect of success; but he asserted that the risks attending exposed electric mains were fewer than the risks which attended either telephone or telegraph wires. When snow fell upon an electric light main it inevitably melted, but it accumulated on other wires with the result that serious accidents were not uncommon. He hoped that the Bill before their lordships would be read a second time. Hereafter he intended to place before them a Bill of his own.

The EARL OF ONSLOW said that the Bill as explained by the noble lord opposite was much less important than it was as printed. There was a clause in the Bill which covered a great deal of ground and repealed a provision of the existing Act; but he understood that when the Bill was considered in committee the whole of that clause would be withdrawn in order that to the term of twenty-one years during which provisional orders must now run a further term of twenty-one years might be added. The Bill, as it was amended, did not appear likely to be productive of great harm, and he was prepared to assent to the second reading on the conditions the noble lord had suggested.

LORD HERSCHELL was not quite sure he understood what it was the Government was prepared to assent to. As far as he could gather it was that the Act of 1882 was to be amended by substituting 42 years for 21 years. If no other alteration was to be made he much doubted whether the Bill would have the effect desired. In this country we had not made the advance in electric lighting which had been made in other parts of the world. He had long desired to avail himself of this important improvement, but he had found it to be utterly impossible for the reason that the Legislature had put impediments in the way of the spread of this invention which was not put in its way in any other country. He believed that in the South Sea Islands the electric light was more used than it was in London. (Laughter.)

The MARQUIS OF SALISBURY: I sympathise entirely with the remarks of the noble and learned lord, but I cannot help remembering that he was a member of the Government which passed the Act that he has denounced with so much vigour. (Laughter.) When I sat exactly where he is sitting now I pleaded in vain for a greater extension of the number of years, and I prophesied the results which have actually occurred. I rather think the noble and learned lord opposite is imitating those sectaries of the Middle Ages who went about laying stripes on their own shoulders for the sins they had committed. The noble and learned lord had held up to our admiration the example of the South Sea Islands in this matter; however, I am too delighted to see that the noble and learned lord recognises the difficulty in which we find ourselves to be critical as to the precise means by which his conversion was brought about. It is a matter of regret that we have not been able to make greater use of this invention, considering the vast amount of capital we have at our disposal and the great need in our smoky towns of diminishing the unconsumed carbon in our atmosphere. Although the Board of Trade has, acting under the guidance of the distinguished statesman who presided over it during the term of office of the noble and learned lord, to some extent, I am afraid, since that time, exaggerated the danger of liberty in this matter, it is fair we should remember that we have had very severe lessons in respect of leaving uncontrolled powers to municipalities and public authorities to make binding bargains with trading companies (hear, hear). On the subjects of water and gas we have had very severe lessons, and we are now struggling under the difficulties that have arisen. The noble viscount near me (Viscount Cross) was said some years ago to have wrecked the Government by the proposals he made for the purchase of the undertakings of the London water companies. We now only wish that the proposals which were then denounced could be revived with success and carried into effect. We have bound ourselves by promises to the water companies which give them a hold upon us that I do not know we shall ever shake off. Undoubtedly, the price at which this essential article may be furnished must have very considerably affected the progress of sanitary measures so much required in many parts of the metropolis. We have contrived to make some agreement with the gas companies. Twenty years ago we woke up to the fact that we had allowed most improvident agreements to be made with them, that we had allowed them, on the faith of competition which did not exist, to charge enormous prices. At the present moment, in regard to gas companies, we are under difficulties which could not have been foreseen by our forefathers when these terms were made, or I am convinced that the measures which they allowed to pass would have been seriously modified. The truth is that in both these cases we have made exceedingly bad bargains, and we are bound by them; and, therefore, it is not wholly unreasonable that in dealing with this new element we should approach it with some amount of caution. I quite believe we may have been too cautious, and may have run into an opposite extreme, and, by hindering the production of the electric light at the cheapest prices, may have prevented the development of this new industry. If the noble and learned lord can show us that the terms we ask can be reasonably modified no feeling of self love will prevent us from making any alteration which your lordships may think desirable. I feel that the whole question of the expediency of giving this power to the municipalities has of late years been too much assumed without sufficient proof, and we should be cautious about surrendering ourselves wholly to them and preventing that protective competition of private companies which is so desirable in the interests of the community at large (hear, hear).

After some remarks from the EARL OF KIMBERLEY, the Bill was read a second time.

GERMAN UNION TELEGRAPH AND TRUST COMPANY (LIMITED).

The report of the Directors of this Company for the twelve months ended December 31, 1887, states that the total receipts during the twelve months amount to £15,368, which, with a balance of £31 brought forward from last account, make a total of £15,399. The expenses for the same period amount to £892; of this sum £750 is provided by the German Union Company of Berlin. Out of the receipts an interim dividend of 5s. 9d. per share was distributed on January 17 last, and the Directors recommend the payment of a further dividend of 8s. 3d. per share, making a total distribution for the year of 14s. per share, free of income-tax, or at the rate of £7 per cent. per annum (as against £6 paid last year), leaving a balance of £156. 3s. 5d. to be carried over to next account.

The proposal of the Imperial German Government for the acquisition of the cables and property of the Berlin Company has been accepted, and an agreement on the terms sanctioned by the extraordinary general meeting of this Company of November 23th, 1887, has been entered into, subject to the formal approval of the Reichstag, which is daily expected. The result of the agreement will be, so far as can at present be foreseen, that the Berlin Company will begin to go into liquidation in April next, and that the shareholders of this Company will receive a return in respect of their capital early in 1889, when the Government will pay the purchase money.

The exact sum to be paid to the shareholders of this Company cannot be determined at present, but it will probably be about par—that is, £10 per share, less expenses of liquidation, which will make a fractional reduction.

NEW COMPANY REGISTERED.

THE ELECTRICAL WORKS CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—Registered by George Annesley Grindle, 19, Great Winchester street, E.C., with a capital of £2,000 in £1 shares. Object, to carry on the business of electricians and electrical engineers.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts for the week ended 2nd March amounted to the sum of £4,435.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of February amounted to £51,261, and to £46,900 in the corresponding period of 1887.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of February, amounted to £38,795, and to £35,553 in the corresponding period of 1887, showing an increase of £3,242.

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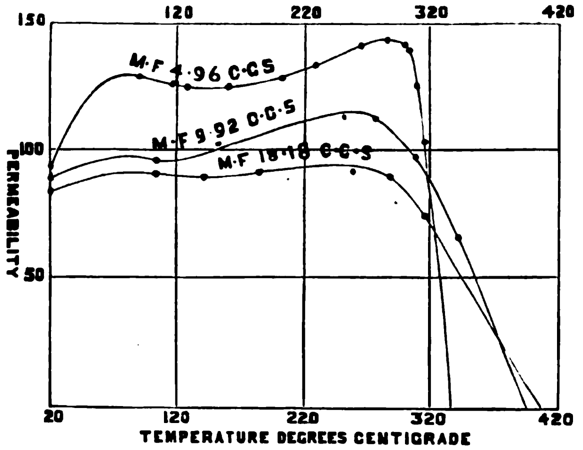
PHYSICAL SOCIETY.

At the meeting on Saturday, February 25, two other papers of electrical interest, in addition to the one reported last week, were communicated to the society. The first of these was by Mr. Herbert Tomlinson, B.A.,

"ON THE TEMPERATURE AT WHICH NICKEL BEGINS SUDDENLY TO LOSE ITS MAGNETIC PROPERTIES."

The critical temperature for nickel is well known to be higher than that of iron, and from 300° to 400° C. is generally given as the limits of temperature within which the former metal loses its magnetic susceptibility. In the present communication the author describes the results of a series of experiments on the permeability of nickel at different temperatures, and for various magnetising forces.

These results are shown for three values of the magnetising force by the curves in the diagram below, in which the temperatures in degrees centigrade are taken as abscissæ, and the corresponding values of the magnetic permeability as ordinates.



It will be seen from the diagram that the greater the magnetising force, the higher is the temperature at which magnetic susceptibility ceases, and that this loss of susceptibility is much more sudden for low than for high values of the magnetising force. The suddenness is also considerably diminished by the presence of any impurity.

In order to see how sudden the loss would be in the case of a very thin metal of the greatest attainable purity a piece of thin brass wire was coated with electrolytically deposited nickel, and was suspended by a platinum wire between the poles of an electro-magnet, and when unmagnetised was kept by the torsion of the suspended wire in a position at right angles to the lines of force.

The wire was then heated up to about 500° C. by means of a Bunsen flame, the circuit of the electro-magnet was closed, and no effect was observed. The circuit was then broken, so that only the residual magnetism could affect the nickel-coated wire, and the latter was allowed to cool. This experiment was exhibited to the society, and a few seconds after the flame had been withdrawn the wire was seen to turn through a right angle with startling suddenness, and was then attracted and remained adhering to one of the poles of the electro-magnet.

Mr. SHELFORD BIDWELL asked whether the first maximum shown in the curve for magnetising force 4·96 was always found, or whether it was an accident of the particular experiment. He would like to know whether a small difference of, say, 5 degrees at the ordinary temperature of the air would have any sensible influence on the permeability, as some experiments which he has not yet published suggest that this may be the case.

Mr. MORDEY observed that after the withdrawal of the flame, of which some experimental forms had been tried, a perceptible time appears to elapse before the nickel becomes magnetic. This was a point of practical importance in relation to thermo-magnetic generators, a great defect in which was that, making some 200 or 300 revolutions a minute, and having imperfect provision for cooling on emerging from the flame, there could only be a small fall of temperature. He would like to know if Mr. Tomlinson had made any experiments on the practical limit to the rapidity.

Mr. TOMLINSON, in reply, stated that the maximum referred to by Mr. Bidwell was found to occur regularly, and he thought that there was much too great a tendency to smooth down the observed irregularities in drawing magnetic curves. He pointed out that the diagram clearly showed that the rapidity of increase as well as of decrease in the permeability depends on the amount of the magnetising force.

In the absence of Mr. W. W. Haldane Gee, the SECRETARY then read his paper on

"EXPERIMENTS ON ELECTROLYSIS."

The author finds that when a dilute solution of sulphuric acid is electrolysed with palladium electrodes, if the current is reversed, streaks such as would be produced by a dense liquid streaming downwards are at first seen proceeding from the pole which is now the anode, and as long as the streaks continue no gas is evolved from the anode. The streaks disappear, and the evolution of gas begins after a time, depending on the duration of the current before reversal, on the strength of the current, and on the size of the electrode forming the anode. Removing the electrode and cleaning it by rubbing prior to reversal does not have any influence on the result; but if the electrode is heated to redness before being replaced the streaks are no longer formed. The author therefore concludes that they are due to hydrogen occluded in the electrode forming compounds with SO_4. Similar results are obtained by the electrolysis of pure phosphoric acid and of solutions of the caustic alkalies. The author states that the presence of these streaks exercises an effect on the resistance, which will be made the subject of a further communication.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

STUDENTS' MEETING.

A meeting of the students took place on Thursday last, the 1st inst., Mr. W. M. Mordey being in the chair.

Mr. W. E. Hayne opened a discussion upon Mr. Cockburn's paper on "Safety Fuses, &c.," describing several improvements, one of which is to replace the leaden pellet, an essential part of Mr. Cockburn's fuse, by a small spring; a duplex cut-out was also mentioned (devised by himself and his brother), in which a second fuse is thrown into circuit after some definite time, useful in cases of accidental or designed short circuits, lasting only for a short time.

Messrs. Lamb, Hume, Rance and Mordey continued the discussion. A vote of thanks to the chairman terminated the proceedings.

ALTERNATE CURRENT TRANSFORMERS.

DISCUSSION.—(*Concluded from page 445.*)

Mr. MORDEY said the position of opposition to transformer distribution taken up by Mr. Crompton and Mr. Gordon rather reminded him of a certain historical person, who told the tide to advance no further; but with the difference, that whereas King Canute knew the sea would not obey him, the gentlemen who had spoken did not. He thought there was no doubt whatever, from what had been seen, on the other side of the Atlantic at any rate, that transformers had a very great future before them. Mr. Crompton said that the bottom would be knocked out of his argument if it could be shown that small alternating-current dynamos could be used and could be put in parallel. It was easy to knock the bottom out of the argument. In the United States machines were being run in parallel not only in one large station, but it had been done across rivers. A station on one side of a river is supplying mains connected with a network on the other side, as well as on its own side; and when it is necessary to put more power on the mains, the dynamos on the other side of the river are switched in. He did not think there was any serious difficulty. There was one objection he would like to make to the conclusion of Mr. Kapp's paper, and that was as to the use of low-tension networks with transformers. It seemed to him that the great advantage they had in transformers was that they got rid of the enormous cost of a low-tension network. Everybody had known that the cost of the copper in a low-tension distribution system had been a very serious item on the whole. It seemed to him that as transformers regulated so perfectly, and as they could be made to regulate even more perfectly than they did just in their simple state, and as they were undoubtedly very efficient indeed for small loads, and further, as loss in the main conductors could be at a practically small cost rendered of no practical effect whatever, it seemed to him that they got rid entirely of any necessity for the distribution network. They only wanted a distribution network that would help one part from another when the wires of any one part were not sufficient to carry a full current. He also disagreed with Mr. Kapp as to the danger of having separate transformers for every house. It might not be necessary to put them in every house, but he certainly thought that if some simple arrangement were made for cutting out a transformer when anything went wrong with it, it was the very best thing they could do. They might put a number of transformers right along the mains, and just one house would be cut out and no more when the transformer in that house went wrong. He even went so far as this, that in a big house like a hotel he would run the mains round outside the buildings; he would take the wires in at two or three places from the outside, and put transformers at those points. To that extent, perhaps, a network system might be used—that is, with the inexpensive primary rather than the expensive secondary conductors.

With regard to the employment of series or of parallel systems of connection he thought the advocates of the series connection of transformers forgot two difficulties. One was that the regulations of the constant-current system with an alternating-current dynamo was not at all easy. He did not know that that had been done yet. They could regulate and maintain a constant current with a direct current system, but for an alternating system this problem had not been solved in practice. The

regulation of the transformer alone only solved one part of the problem. They must have a constant current in the first place. When they had got a constant current it had been shown in two ways, by using lamps in series and by using Mr. Kent's very ingenious arrangement of the impedance coils, that it was possible to regulate the transformer. But they had got to start with the dynamo at the station, and they had not got over that preliminary difficulty yet. Then the second difficulty was that in a series or any other system what limited the engineer was the E.M.F. They could only work up to 2,000 or 3,000 volts. When they had got there they must stop and begin to increase their leads. He thought it was just as well to start with the parallel system, in which there was no problem that would have to be solved as they went on. But even if the constant alternate-current dynamo were forthcoming—and he felt that if such a machine were necessary to progress it would be produced—the self-regulating powers of the series system would be seriously hampered by the want of pliability found in the arrangement and connection of the lamp leads. If the simple series of lamps of large current and low potential were used the conductors would be large and troublesome; if groups of ordinary lamps in multiple series were employed, there were all the old complications of multiple series working; but single lamps of a group could be switched off by using impedance coils, though only with further complication and expense. Besides all these connections the series system would sometimes land us in the ludicrous position of having introduced a higher difference of potential in a house than we had outside of it. We should actually have to transform up instead of down from our high-tension mains. This would be particularly the case with a primary current of any considerable amount.

Mr. Bernstein had said that it was necessary to run the two mains for parallel work close together, but that this necessity did not exist with series mains. This was, he thought, a mistake, the necessity being equal in the two cases. It was thus probably not advisable to have a large open loop of a single main out and home, as was often done in continuous current work. This whole question of series or parallel connections demanded more than a passing notice, and the present was the time when the advocates of either system should justify their position. While admitting that for very small work (in which, however, it would be better to employ continuous currents) transformers in series might be used with advantage over transformers in parallel, he thought that for general distribution parallel connections would become almost universal.

He was very glad to see Prof. Ayrton making use of the calorimeter method of testing the transformer. He believed that method, even roughly carried out, could be made very accurate. About a couple of years ago he tried an experiment of this sort in the works of the Brush Corporation. He took a box—an ordinary packing case—and made it watertight, put a resistance coil in it, sent water through it, and sent a current through that resistance coil. He wished to measure the energy, the current and the difference of potential, which he did not know, being taken by independent observers. Using a bucket to measure the amount of water passing through this rough calorimeter, a couple of thermometers to take the temperature of the incoming and outgoing water, a result was obtained which worked out to within 4 per cent. of the actual energy as shown by the independent volt and ampere readings. That method could be easily applied as an absorption method of testing alternating currents. Unfortunately, it could not be used as a transmission method. It would thus be quite possible to carry out an electrical test without any other instrument than a thermometer.

It had been remarked by a previous speaker that it was not possible to decrease the speed of alternating-current dynamos for small loads because the alternations must be kept the same. Might he be allowed to mention a method by which it was possible to decrease the speed and to keep the alternations the same? He did not know that it was a very practical method, but at any rate it would work on paper. If they took an ordinary Gramme armature, and put a laminated field to it, and sent an alternating current at a given rate of alternation around the field, they would get from the ordinary continuous-current machine an alternating current with the same rate of alternations. If they kept a constant field they would get an electromotive force which would be directly proportional to the speed. Thus, it would be possible to vary the speed, without changing the rate of alternation, and to vary the current or E.M.F by a combination of speed and field regulation. The only thing that would be necessary would be to have a small machine which could be separately driven to excite the fields at a given rate of alternation.

He might, perhaps, mention another experiment that he had made. Mr. Kapp with his diagrams could at once see what was going to take place in a transformer, but some of them could not, and they liked to be able to see it if they could in a practical way. He wanted to be able to get something that he could look at that showed the lag in a transformer, and he should like to submit his method for criticism. Perhaps Mr. Kapp would tell him if it was a wrong method. If they were to take two transformers and join, say, the high-tension coils in series and send an alternating current through the low-tension circuit of the first transformer from a dynamo, as in Fig. 5, then, of course, they would get a current in the low-tension circuit of the second transformer, which might be used, say, for running glow lamps, and the momentary currents in the two coils would at the same time be (roughly) in the same direction, as shown in the figure. Suppose, then, that a certain difference of potential is maintained at the terminals 1 and 2 of the first transformer, as shown by a Cardew voltmeter, then there would be practically the same potential difference between terminals 3 and 4 of the second transformer, as would be shown by the voltmeter. The readings would not be quite alike, on account of the small loss due to the double transformation up and down. Now if terminals 2 and 3 were connected as in Fig. 5, and the voltmeter were placed across the terminals 1 and 4 it would, if the waves absolutely coincided, indicate the sum of the two previous readings; but if the waves did not coincide in phase the reading would be less than the sum of the two first readings, and the amount of this reduction might be made a measure of the difference of phase. Instead of connecting the two coils, as in Fig. 5, they may be joined together and to the voltmeter, as in Fig. 6, when it will be seen that the indication will be zero if there is no difference of phase, any indication on the voltmeter showing that the waves were not coincident. He had tried the experiment not only with two but with six transformers, connected in the same manner, in a series, and using the first and the last coils of the series connected, as shown, and in neither case had he been able to find any indication of lag, not even when there were many steps in the transformation processes.

Owing to the news (which he was sure they all very much regretted) of Mr. Gaulard's mental illness, he was a little reluctant to say anything about the theories put forward in Mr. Mackenzie's paper, many of which were open to question. He thought, however, one could not pass over the statement that it was not till the views of Faraday had been proved to be erroneous that it was found possible to make any advance in transformer work.

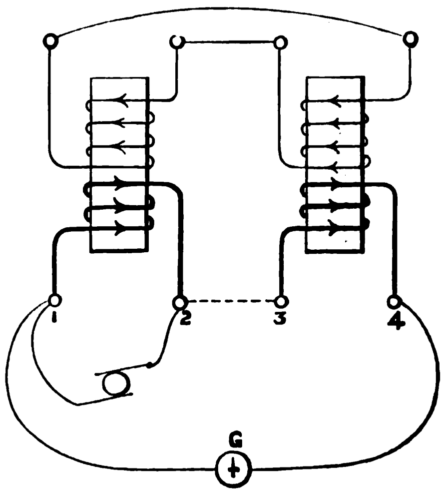


Fig. 5.—Connections of two transformers to give *sum* of E.M.F.'s on voltmeter G. Terminals 1 and 2 to dynamo, 3 and 4 open, or to lamps. Terminals 2 and 3 connected, 1 and 4 to voltmeter.

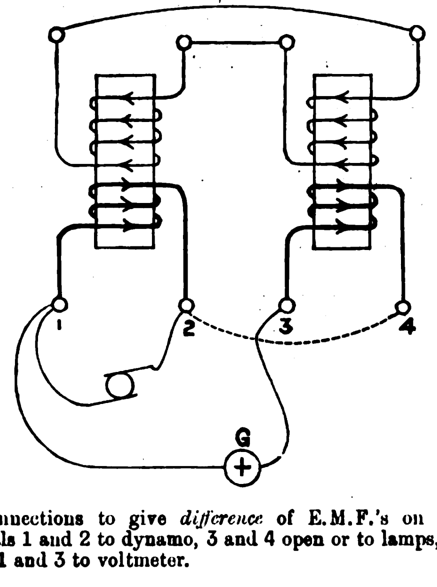


Fig. 6.—Connections to give *difference* of E.M.F.'s on voltmeter G. Terminals 1 and 2 to dynamo, 3 and 4 open or to lamps, 2 and 4 connected, 1 and 3 to voltmeter.

Mr. Willans, on being invited by the President to take part in the discussion, said that he could fully corroborate what Mr. Crompton had said about large engines working at very low power, although it would not be quite the same with condensing engines as with non-condensing engines.

Mr. T. Blakesley said he would touch upon some points that had been raised in the discussion, though not, perhaps, in chronological order. First with reference to the method which had just been pointed out of measuring the current phase. Some years ago he found a method of measuring precisely the phase between two alternating currents, and that method had met with such approbation from Signor Ferraris that that gentleman had done him the honour to adopt it as his own. It was this:—An ordinary two-coil dynamometer was employed. If they used these two coils in series they could measure the currents. They could apply this method first to one of the coils and then to the other, and then if they pleased they could send one of the currents through one of the coils, and the other through the other. This reading gave them without the smallest difficulty the cosine of the angle

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between the two phases. Nothing was simpler, and nothing was easier to prove than that. If Mr. Kapp would try this method with his primary current and secondary current in his transformers he thought that that gentleman's mind would be enlightened as to some facts which he had put forward in connection with this subject Mr. Kapp had drawn a line representing the phase of magnetisation in his core, and he had made that correspond with the resultant field of the current in the secondary coil and the current in the primary coil. That, he maintained, was altogether at fault if hysteresis was a fact. If hysteresis was no fact, he had nothing to say on the matter, but Mr. Kapp himself agreed that there was a considerable quantity of hysteresis in the reversal of the polarity in the mass of iron. He would point out what he meant. O I_1 (Fig. 4, *The Electrician*, Feb. 10, page 340) and I_1 P together made up something which was the same phase as O P, the magnetic field due to the currents, but he denied that the magnetisation phase corresponded with that, and he denied it on this ground. If the magnetisation phase coincided with O P, the phase of the increase of magnetisation was at right angles to O P, and therefore its projection upon O P equalled nothing at all; and as the product of those two things was, in proportion to the hysteresis, the magnetic field and the increase of magnetism in the magnetic field—since that would be nothing—hysteresis could be nothing, and the magnetisation must, in fact, follow the field of magnetisation produced by currents. In fact, Mr. Kapp had left out a certain line which was an induced magnetic field due to the increase of magnetism itself. That was a fact he thought not very often recognised. If Mr. Kapp proceeded in a way that perhaps was rather too complicated to go into now, without much difficulty Mr. Kapp would work out his complete figure, only without the knowledge of one thing—viz., the coefficient of this hysteresis, which, of course, was a thing he was seeking; but if he applied this dynamometer method to find the phases between the two currents, the result would be that his figure would be completely determined and the hysteresis come out as a function of these dynamometer observations. He thought it was very right of Mr. Kapp to indulge in these geometrical figures, for he had done so very largely himself. He thought, however, that Mr. Kapp was wrong in placing in the same diagram things of an apparently different sort. Mr. Kapp had not kept all his lines of the same sort in the same diagram. If Mr. Kapp had been successful in his representation, perhaps he (the speaker) would have had to quarrel with him on another account, because he thought he himself had started this subject of representing phase geometrically before Mr. Kapp did, but he must entirely disclaim that figure representing the phases of the two magnetic forces by the resultant magnetisation.

Mr. ARTHUR WRIGHT, referring to Mr. Kapp's statement as to the superiority of the core transformer over the shell transformer, thought that Mr. Kapp had lost sight of the fact that nearly all the heat of the transformers was produced in the iron. The iron being outside, the shell transformer was better able to lose its heat than in the core transformer. If Mr. Kapp took that into consideration he would find that the shell transformer was very much better than the core transformer, as in this latter form the heat had first to warm the copper and so increase the loss in volts before it could escape.

In central station work it was very important to have a very small current indeed passing through the primary when the secondary was open, because in the case of a day and night supply, this current would mount up to a considerable value when there were many houses connected on the system. He thought it was most important to fully investigate each form of transformer on the basis of comparing the through current; by the through current he meant that passing through the primary with the secondary circuit open. With regard to safety, perhaps the simplest plan would be to connect the secondary circuit to its circuit earth through a very high-resistance inductionless coil, and to have a magnetic tumbler in which, when the tension of the secondary circuit was sufficiently high, would short-circuit the secondary terminals, and so fuse the primary fuses and cut out that transformer. That was simpler than any electrometer method, and he thought safer than the proposal of putting the secondary to earth. The question of getting over the difficulty of putting converters outside houses was most important, and he thought it might be overcome by putting the converter into cast-iron boxes with water-tight joints and placing a very small vessel of sulphuric acid to condense any moisture that might arise. He thought the danger of having a high-tension converter inside a house ought to be considered. With regard to Mr. Crompton's challenge about the cost of the unit, if Mr. Mackenzie was not going to give the figures asked for, he himself would be very happy to supply those that they had worked out at Brighton of the cost per unit throughout a whole year under all sorts of loads. Mr. Crompton in his figures must take into consideration the enormous cost per unit for depreciation of batteries and attendance, and he ought not to lose sight of the fact that management and superintendence mounted up to a very large figure. With regard to measuring the efficiency of a transformer by calorimeters, that seemed difficult in large transformers. It was very difficult, indeed, to put a 6 or 7-unit transformer in a vessel of water without losing a good deal of heat by radiation. With regard to Mr. Kapp's question as to the advisability of having one transformer to every house, or one to many houses, that he thought depended upon how the houses were situated in the system. Looking forward to the next two or three years, he thought it would be very difficult to get a number of consumers close together. However, when they did get two or three consumers close together, by all means let them put one converter for the group; for many years to come he did not think that would be the case, and for some time at least he thought they would be compelled to have separate converters for every house.

Mr. MADGEN referred to the statement in Mr. Mackenzie's paper that it was only when M. Gaulard came to the conclusion that induction apparatus constructed upon the theory founded by Faraday, and exemplified by Ruhmkorff, was unsuited for the purpose that success crowned their efforts. Perhaps Mr. Mackenzie would explain a little more fully what he meant by that. His reason for referring to this passage was that some time before Messrs. Gaulard and Gibbs commenced their experiments Jablochkoff had done a great deal of good work in this direction. Mr. Mackenzie went so far as to say that Jablochkoff and others had given a great deal of attention to this matter, but he thought Mr. Mackenzie had not done Jablochkoff sufficient justice. There was a drawing on the wall of Jablochkoff's transformer, which seemed to combine very important essentials, amongst others the closed magnetic circuit. That was considered by Jablochkoff to be the best form long before 1885. Of the modern types of transformers there seemed to be too much of a muchness; in fact, they were all very much alike. There was a strong resemblance between the Westinghouse transformer and the very excellent transformer designed by Kapp and Snell. Probably the most ingenious modern development in connection with transformers were the impedance coils of Messrs. Sharp and Kent.

Prof. SILVANUS THOMPSON said that he had read Mr. Kapp's paper with very much pleasure. He could not pretend to discuss it at that late hour. He appreciated very much the way in which Mr. Kapp had handled these geometrical diagrams. It seemed to him that Mr. Blakesley did not quite understand one point in those diagrams—as to what O P represented. It did not represent current, but the resultant magnetisation of the two currents. Although he appreciated much the good work Mr. Blakesley did three or four years ago, he thought they ought to acknowledge their indebtedness to an older source than even Mr. Blakesley for the use of geometrical diagrams for representing things of this kind. The thing was to be met with in the pages of Thomson and Tait, a treatise from which he supposed many of them imbibed many years ago. Coming to another point of Mr. Kapp's paper, he must confess that he could not agree with that gentleman in dividing transformers into core transformers and shell transformers. Where did the one begin and the other end? When did a core become a shell, and when did a shell become a core? All the same, he wished to express his indebtedness to Mr. Kapp for the excellent way in which he had put this subject before the society, and for the very impartial manner in which he had distributed his favours to rivals. He wished he could say the same of Mr. Mackenzie's paper. He was not present when the paper was read; but reading it over quietly at home he found much to seriously criticise. The statement that the theory founded by Faraday had to be abandoned was simply untrue.

Mr. MACKENZIE was understood to dissent.

Prof. S. THOMPSON: I mean this passage:—"It was only when M. Gaulard came to the conclusion that induction apparatus, constructed upon the theory founded by Faraday and exemplified by Ruhmkorff, was unsuited for the purpose, that a step was made in the right direction."

Mr. MACKENZIE was understood to say that there was some error there. He meant to say "as exemplified by Ruhmkorff." It did not interfere with Faraday's idea. It was an exemplification of the Ruhmkorff and Faraday idea.

Prof. S. THOMPSON said that the "Ruhmkorff and Faraday type" occurred two lines lower down. He thought that statement was rather extraordinary. Again, he did not understand what the result would be of dividing things into a class of Gaulard type and of non-Gaulard type. He saw here that in a transformer of the Gaulard type the secondary was "placed in an identical position with regard to the iron core as the primary." So far as those drawings show, the only way to do that was to have one wire of the secondary coil between one wire of the primary—that was to say that they must not have any coefficient of transformation at all. He admitted that it was a real novelty to use, as M. Gaulard had done, flat metal washers instead of wire coils; but the transformer so constructed was wholly unsuitable for distribution in parallel; it had a maximum risk of break down with a minimum performance. To put the secondary wire in "an identical position with regard to the core as the primary," as shown in Mr. Mackenzie's drawings, was to invite failure of insulation. If it did not mean that, he failed to see that it was very different from anybody else's transformer. He must refer to one other statement—a statement on page 3—that when Messrs. Gaulard and Gibbs first exhibited their system at the Westminster Aquarium, at the beginning of 1883, only one transformer was there shown in work, and this one was consequently "either in parallel or series" with the dynamo. That was rather a misleading statement. What was meant by two things being in parallel? It meant that the current flowed through both in parallel from the same point—from the same point on one side towards the same point on the other. But with one dynamo and one transformer, did they mean to say that those were in parallel? It was absurd. They were in series, and could not be anything else but in series. It was a misleading statement, and it certainly ought not to be put down in the paper. He would leave that paper, however. He had given them a sample of what had been put in it. Now he came to Mr. Crompton's remarks, which he felt ought not to go unchallenged. What was the basis of Mr. Crompton's position? It was, firstly, that you must distribute something under 500 volts. Why did he not take 5,000 or 10,000? For a very good reason, because his dynamos would not do it. With 2,000 volts on an ordinary Gramme commutator, made of parallel metal bars insulated with mica, how many years would it last? They had got to find some other commutator arrangement if they were to work at 5,000. He did not say that there were not such machines.

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Mr. GORDON: What about the Brush machines?

Prof. S. THOMPSON: They had not a commutator of the same kind. Then there were the Thomson-Houston machines. They had not a commutator of the Gramme kind, nor would any constant-current machines that would work with anything like 2,000, 3,000, or 5,000 volts. There was a second assumption underlying Mr. Crompton's whole argument, which was that alternate-current dynamos were necessarily bad as compared with continuous ones, because they required so much room and were very wasteful and would not work in parallel. He was afraid Mr. Crompton was not up to the latest in alternate-current machines, because he happened to know that there were alternate-current machines—they might hear about them, perhaps, in that room before many months were over—that were just as much better than the alternate-current machines already known as were the continuous-current machines of the present day compared with those of five years ago. As to machines not working in parallel, they had indications enough in that room, both from Mr. Mordey and other gentlemen, as to how such things might be done. Put into the circuit of the two machines that are to be synchronised two coils, and let those two coils act as one another, like Prof. Perry's two coils; as long as there was a similarity of phase, they would have an action between those two coils; directly they got difference of phase the action of those two would cease. The motion of the two coils might then be caused to work an automatic regulator. But there were other ways of doing it which he supposed had not been worked out because there had not been until now this great demand. As to the sine curve, he had pointed out, on more than one occasion, that the question of what curves they got for the wave of induction was merely a question of the shape of the pole-pieces. It was perfectly true that the self-induction current acted as a harmonic fly-wheel to flatten down the ripples, and tended to make the form of the wave approximate more nearly to that of its principal harmonic period. He did not think, with all due deference to Mr. Esson's curve, that the machine that gave such a curve was well designed. If it was really a curve of induction, it was perfectly clear that the pole-pieces might have been better shaped. He should wish finally to say that he had no great liking for the alternate current. If he had differed from Mr. Crompton that night, it was not because he did not think that storage in itself—in the abstract—was a great deal better, but he did not at this stage of things want to see any unnecessary difficulties put in the way of the fullest and most complete trial being given to the system of distributing light by transformers. Lastly, he was very sorry that they had not heard that night, or in any previous night's discussion, any mention made of continuous-current transformers of the kind known sometimes as motor dynamos. They appeared to him to be a real success. He was sorry that they had not some contribution from Messrs. Paris and Scott to show how they had been carried out. They knew very little about those machines. When they were doing their work properly the currents in the incoming coil on the armature and the outgoing coil neutralised one another's self-induction. There was a mutual induction between the two, and as a result here, as in the alternate-current transformers, the self-inductions of the two separate coils were practically wiped out by the mutual induction between the two. The consequence was that these machines hardly sparked at all when they were doing full work. It was clear that for all purposes of distribution transformers were the order of the day, whether by alternate currents on the one hand, or by accumulators, or in the third case by motor dynamos. It was clear that they had to study this question of transformation in all its bearings for the basis of immediate distribution.

Mr. KENT asked Mr. Mackenzie to explain the passage in his paper in which he said the "secondary circuit"—that was, he supposed, the "current"—varied directly with the square of the current in the primary. He thought that was not the case. As regarded his device for shielding the secondary circuit from the primary, perhaps he had better explain that this shield is not a bare copper band connected to earth inviting the primary to leak into it, but a heavily insulated band, and so arranged with respect to the two coils that should there be any *tendency* on the part of the primary to leak, it would leak into the shield before it got to the secondary coil. Suppose such a leak does take place, what happens? Why, if there is any other leak on the circuit, an excessive current flows through the two leaky transformers, the cut-outs melt, and the transformers are cut out of circuit. Next, suppose the primary leaks into the shield and also into the secondary—well, then we only arrive at Prof. Ayrton's suggestion of earthing the secondary, and yet he thinks his plan simpler! He considered the practice of earthing the secondary would be very reprehensible. As regards supplementary devices, he had sketched out several to be inserted in the earth wire—that is, between the shield and the earth, some of which might be made to indicate a leak, or ring an alarm if a leak occurred. Coming now to Mr. Kapp's paper, he did not at all agree with him as regards series working. He thoroughly endorsed all Mr. Bernstein had said on the subject. There are three distinct ways of obtaining self-regulation when the primary coils of the transformers are in series.

1st. By putting all the lamps in series on Mr. Bernstein's system.

2nd. By the use of what have been called our "choking" coils, or what we prefer to call "impedance" coils.

3rd. By building up the transformer in sections so far as the core of the secondary is concerned, and connecting each lamp or group of lamps to its separate section.

The first and third of these methods is admirable for small or medium-sized transformers, and the third will do for any size All three are perfectly self regulating. As the second method has been described elsewhere, we would not take up your time with it here. From their experiments they had found that an induction of 5,000 is quite high enough for satisfactory working.

Mr. KAPP, in reply, said that in the first place he would answer Prof. Silvanus Thompson as to the difference between the core transformer and the shell transformer. The shell transformer had one set of coils and two cores or more. A core transformer had one core and two sets of coils or more. Now, as to Mr. Wright's contention that the shell transformer was superior. He quite agreed with that gentleman, and that was the reason why he made *his* a shell transformer. He did not say the Zipernowski was superior, he said it was inferior. It was a shell transformer of a circular ring type. It might interest Mr. Wright to know that what he (Mr. Kapp) arrived at through calculations Zipernowski had found out by experiment. He had abandoned the Zipernowski type of transformer and now made ordinary Gramme rings.

Mr. Mordey suggested a very interesting experiment. The angle of lag in one or two of his (Mr. Kapp's) diagrams was so small that the cosines had such values as ·999; so that they might imagine they could not get an appreciable difference in the readings. Probably there was a difference, but the error of the measuring instrument was greater than the difference.

As to the cost of the network, he objected to putting transformers into houses simply on the ground of safety, and he thought whatever they did that they must study the safety of their customers before the coal bill and before any other consideration. As long as they had transformers in the houses they were not safe. Children would put their hands on the terminals and accidents would happen. When they put the transformers outside they had the other advantage, that if one transformer broke down the houses in the immediate neighbourhood were not in utter darkness, because the other transformers would supply a little more and it would flow through the network to those houses. They were bound to have a network, and instead of having such enormous mains as Prof. Forbes brought before the society some time ago they would have mains with a very small section, with transformers every fifty yards. The mains would be exceedingly small, and need not cost more than Mr. Crompton's mains. If they adopted the principle of distributing the secondary currents by means of a proper network, once they had laid it down, they could use it when that happy time arrived when they could employ the battery system. Mr. Esson asked a question about the weight of transformers. This depended entirely on the size. Some of the transformers exhibited weighed a pound and a-half for every lamp. The small transformer that Prof. Ayrton tested weighed two pounds to every lamp. One and a-half pound for a lamp would be the average for medium sizes.

He would now deal with Mr. Gordon and Mr. Crompton. When he heard those two gentlemen speak he began to feel very doubtful whether after all they were not all of them going on a wrong line; but then he was comforted with the idea that supposing even such a man as Edison, or Brush, or Westinghouse had been present, and had seen Mr. Gordon's diagram, he would have gone home disheartened, and resolved never to put up a central station again because of the enormous consumption of current when the people had gone to dress for dinner. But what was the fact? How many battery stations were there in the world? He knew of absolutely only one in London, one in Berlin, and one in Vienna. How many central stations on other systems were at work he was afraid to say, but he thought in America there were something like 1,000. On the Continent of Europe there were perhaps 100 or 150. In England there were, perhaps, fifteen. All these were working on the direct system, and their machinery must be capable of supplying this extra spurt shown on the diagram. But that was a bad case. In reality they could only have that effect when they lighted the same class of houses throughout a district; but in London they never had a district so defined. They had residential mansions, and within a stone's throw they had mews and shops, all within the area which would be supplied from one station. That being the case, they would never have to meet such a state of things as Mr. Gordon suggested. If they had to meet it all they would have to do would be to make some allowance in their machinery. In what way was Mr. Crompton better off than they were? He had to supply this extra amount of light from the batteries instead of from the machines. They would have to put up more cells, and it was the battery which cost the money, not the engines. He was not against batteries in any way. He would hail the day when they could get a good battery, but all the arguments used by Mr. Crompton and Mr. Gordon might have been used with equal consistency three years ago. They had batteries then, and they had very good direct-acting steam engines and dynamos. Had they good enough batteries now? He had not seen them. The batteries which were at the Colonial Exhibition gave an efficiency of under 60 per cent. They were in the hands of experts. Everything was done that could be done. They were under supervision all day long, and yet there was only 60 per cent. efficiency. When it was said that transformers were bad because they had a low efficiency when the output was very small, they must remember that they could work up to 90 per cent. efficiency at a moderate output, and 96 per cent. at full output. He maintained if they put down a network of mains and employed transformers to feed them, no transformer need work at less than a third of its output (where its efficiency was 85 per cent.), for the simple reason that when the output got less they could cut off a feeder and let the network be fed from the others. The point about the dynamos in parallels had already been answered, and that finished the whole argument about the big machines necessary for doing the work. What they would have would be three or four engines, and if they wanted to use a quarter of the power they would use one engine, and if they wanted full power they would let all four of them run.

He would now like to say one word about the question of dynamos. He thought they would go away frightened at the size of the alternate-current machines if they took Mr. Gordon's figures, who spoke of a machine giving 200 kilo-watts, with an armature 10ft. in diameter. Now, the machine which was shown last Thursday on the board was of 60 kilo-watts, and the armature was 40in. diameter. If they built a machine on the

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same lines with a 6ft. armature it would give them 200 kilo-watts, and the machines would weigh about 80lb. per horse-power, which was less than a continuous-current machine.

He would now deal with the discussion of last Thursday. The calorimeter experiments of Prof. Ayrton he thought were very interesting, and, as far as he knew, they were the first exact experiments that had been made. There was one point, however, when experiments of that kind were made to which attention should be given. That was the temperature of the room in which the calorimeter was placed. They should have the mean temperature between the incoming and issuing stream of water about the same as the temperature of the room. That they could always do because they could regulate the flow. Suppose that their room was 15deg. C., if the incoming water was 10deg. C., they could regulate the flow so that the outcoming water should be 20deg. C. Then the mean temperature of the calorimeter would be 20deg. C., and there would be no flow of heat from the air of the room to the calorimeter.

Prof. Ayrton said that this precaution had been adopted.

Mr. Kapp: Several speakers that night and also on Thursday spoke about magnetic lag. He would be a bold man who said whether there was or there was not, because nobody had proved it; but he thought there was not, and his reason for so thinking was that if there were lag he could not see how any telephone could articulate. If there were lag, the lower the voice going through the telephone the better they ought to hear. Now, as a matter of fact, they heard a high voice better than a low voice. The high voices have quick waves, and should be more distorted by lag, but they were not more distorted, and for this reason he was inclined to think that there was no lag, and until somebody showed him actually by experiments that that opinion was wrong he should hold it. Captain Cardew and Mr. Bernstein had objected to the safety device which he put between the two coils, and Mr. Bernstein had characterised it as leading the primary current into temptation. Now, what was this temptation? It consisted of the presence of metal outside the primary current, but between this metal and the coil there was insulation. In what did this differ from the temptation which existed in every transformer? They had the metal in the secondary coils, and they had insulation between them and the primary. With the core itself it was just the same thing. And in what way was the strain brought on the insulation of the primary greater on account of this shield, as compared with the strain which was already brought on it by the presence of the core? They were bound to have iron somewhere, and whether they had it in the inside only or on the inside and outside as well, the strain on the insulation was the same. So that he believed the objection was merely a sentimental one.

Mr. Bernstein had asked a very interesting question—which was the most effective at the lowest output, a series or parallel transformer? That depended on the ratio between the loss taking place in the iron and in the copper. When they worked in parallel the magnetisation was a constant. Therefore, the heat generated in the iron was a constant for all loads. When they worked in series the magnetisation of the iron was very little when the work was little. But as to the heat generated in the copper, this was constant. If there were two transformers in which the heat generated in the iron and generated in the copper for full output were equal, then the efficiencies would be also equal for smaller loads. The efficiency would be the same in both cases at a low output, but inasmuch as generally the heat of iron was more than the heat of copper, the series transformer would be slightly better in efficiency for a low output. Dr. Fleming made a suggestion which he was very glad to hear—that was, that experiments should be made on the heating of iron under different rates of alternation. He hoped that some one would provide funds enough to carry out the experiments. Dr. Fleming wanted to try what was the permeability of iron at different periodicities. That would be interesting in itself. But a far more important question would be, what was the heat generated in iron at different degrees of magnetisation and different number of alternations per second? That was the real question. That regulated the design of transformers. If they could only magnetise their core more than they did now, without producing more heat than they did now, they could make transformers which would be exceedingly small for the output.

Referring to the general question of batteries *versus* transformers he wished them to understand that he was at present in favour of the latter, simply because he had no confidence in batteries. If he knew batteries were good enough he would never presume to put down alternating plant; but he had never seen a good battery, and, therefore, that was the only way of doing the work. It was done everywhere. As Mr. Mordey said, they might as well try to stop the sea as try to stop the employment of alternate currents. But in order to provide for the day when batteries would be good enough, they must put their plant down now so that most of it could be used later on. What would they have to throw away, and what could they retain? They could retain their boilers, engines, and stations. They could retain the whole of the network, and the whole of the distributing plant to the houses. What they had to throw away were their alternating dynamos and the transformers. Both together would not cost more than 10s. a lamp. The wiring and fitting of each lamp in a private house would cost at least 30s. to 35s.; the conductors would cost something like 30s. again; so they could see that by introducing alternating currents they would only risk a possible future sacrifice of about 10s. per lamp in an installation costing from £3 to £5 per lamp originally. Nearly the whole of their plant would remain equally serviceable when the day arrived that batteries could be used. Until then they would find the alternate current and transformer system good enough, safe and reliable for all practical requirements. It seemed to him that there really was no fault to find. They did not advocate a thing which was altogether wrong, and which would be altogether wrong in a few years. They advocated a thing which with a very little sacrifice would be good for the day when they had batteries.

Mr. Mackenzie: In reply to Prof. Ayrton's query as to whether the coils he spoke of were ever seriously tried at the Grosvenor Gallery installation, he would only say that some experiments had been made with an apparatus consisting of a single coil of fine wire placed in shunt to the primary of the series transformers then being used, in which coil was inserted, a core formed of a bundle of iron wires, inserted more or less by hand as the output from the secondary of the transformers varied. No good results were, however, obtained, as the coils that were tried invariably got burnt up in course of time. The idea was abandoned, and no further experiments were made, it being decided about that time to put the transformers in parallel. Mr. Bernstein had suggested that his fusible contact plugs would serve as a means of putting the secondaries to earth should the potential rise above what was proper, and he—Mr. Mackenzie—thought that such an arrangement was quite feasible, and would prove cheaper than the apparatus devised by Captain Cardew, which was, however, in itself an excellent and ingenious contrivance; but he objected altogether to putting the secondaries to earth in an installation based on the transformer system, for reasons which were numerous, and had already been mentioned by previous speakers.

Mr. Atkinson, in referring to the Kingdon dynamo, wondered whether Mr. Mackenzie had experienced, in working this machine, a large amount of alternation in the exciting circuit; and this effect had in reality been observed, though not to any great extent, and was probably due to the causes mentioned by Mr. Atkinson. Mr. Kingdon, in stating that the fly-wheel of an engine would form part of his machine, did not intend to convey the impression that existing engines were preferably to be so altered; but that in designing a dynamo for a central station, the fly-wheel of the engine, necessary in any case to ensure steady running, would be made to form part of the dynamo, and thus combine two functions in one. The object of arranging the machines into various circuits so as to admit of alterations in the coupling was obvious, since bobbins could be cut out of circuit as the output diminished, thus working the remainder at their maximum. There were many reasons why it would be advantageous to be able to alter the connections of the bobbins, but the want of time prevented him going into the matter.

In answering Mr. Crompton's request to give him information regarding the efficiency of the transformer system, he thought that Mr. Crompton was at present asking for rather too much. Regarding the saving of copper used by the employment of this system, reference to the diagram on the wall would make this clear, and he thought that many of the objections that had been raised by Mr. Crompton had been met and successfully answered by several speakers that evening. There would be no gainsaying the fact that the transformer system had made tremendous way, and this would never have been the case had not the system possessed merits placing it before all others for the general distribution of electricity. He quite expected to see Mr. Crompton, before very long, becoming as warm an advocate of the transformer system as he had, not many years ago, been an opponent of electrical distribution by secondary batteries.

Mr. Gordon had gone very fully into the relative merits of the two systems, but he had been answered by several gentlemen who had joined in the discussion that evening, and the speaker was afraid he could not altogether agree with the conclusions Mr. Gordon had arrived at.

Prof. Silvanus Thompson, as well as Mr. Mordey and Mr. Madgen, had called attention to his statement on page 1, regarding the Faradaic theory. He wished to point out that the words, "*and* exemplified by Ruhmkorff," should be "*as* exemplified by Ruhmkorff," M. Gaulard never having dreamt of denying the Faradaic theory of induction, as such would have been absurd on the face of it; but he distinctly laid down the dictum that the Ruhmkorff coil, more or less modified, formed the basis upon which all previous experimenters had worked, and had consequently been utterly unsuccessful. Regarding Mr. Madgen's mention of Jablochkoff, he denied that that electrician had ever conceived the idea of a transformer system as now existed. He quite recollected the apparatus exhibited by M. Jablochkoff, in Paris, at the Great International Electric Exposition of 1881, but that system then shown at work as a "transformer system" was no more—either theoretically or practically—like what Gaulard had discovered, than a Wimshurst machine was like a dynamo, and he did not think the subject worth discussion.

Prof. Thompson had objected to his statement that when one transformer only was connected to a dynamo it was "either in parallel or series;" but he did not see how anyone would prove the contrary, in spite of the argument brought forward by the Professor, since, like a "quarrel," it took more than *one* to make a parallel or series circuit.

Seeing the hour was so late, he was unable to say more in answer to the remarks made by the numerous gentlemen who had joined in the discussion.

The President said that votes of thanks had already been given to the authors of the papers, and, considering the extreme lateness of the hour, he could only say they were very much obliged to those gentlemen for having called their attention to a subject the importance of which could not be exaggerated, and to which their attention had not hitherto been called by any previous writer of a paper. It had given rise to a very interesting discussion, a discussion which had fulfilled the object of most discussions, as it had brought out a great divergence of opinion, from which probably some truth might be hereafter gained.

The proceedings then terminated.

Captain Cardew has been good enough to send us a copy of the curves (Fig. 7) which he has drawn to represent effective exciting power and magnetisation, and to which he referred in his remarks during the discussion on Mr. Kapp's paper, as reported in our last issue. Captain Cardew writes:—"Doddington House, Strood, Kent,

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26th Feb., 1888. I send you my idea of curve representing magnetisation in relation to that representing effective exciting power in a transformer. This is merely an illustration of what I meant at the discussion and not in any way derived from experiment. The curve of effective exciting power is assumed to be sinusoidal. The curve shows the probable lag during magnetisation recovered during demagnetisation, and the sluggishness under weak force due to hysteresis or molecular friction. Of course the magnetisation is supposed to be always far below saturation."

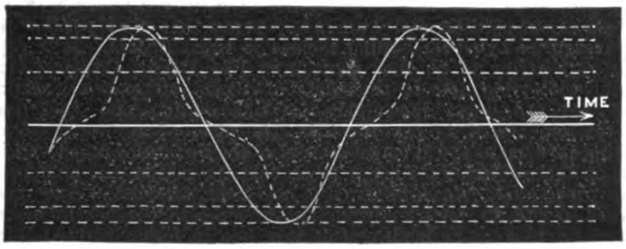

FIG. 7.

Effective exciting power, firm line. Magnetisation, dotted line.

The dotted lines left at 0·5", 0·866", and 1" (sines 30°, 60°, and 90°) show how the sinusoidal curve is drawn, and laying off a scale of ¼" along neutral line in drawing ordinates. The other curve is drawn by eye.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

2,772. K. W. HEDGES. London. Improvements in electrical safety appliances. February 24, 1888.

2,784. J. IMRAY. London. A method of and apparatus for electrically lighting railway and other carriages. (R. Imray, South Australia.)

2,785. E. F. H. H. LAUCKERT. London. Improvements in holders for electric glow lamps. February 24, 1888.

2,794. C. A. M'EVOY. Southwark. Improvements in electrical firing keys or contact makers. February 24, 1888.

2,808. H. F. JOEL. London. Electro-magnetic conductors for electric and magnetic machines, induction coils, transformers, &c. February 25, 1888.

2,819. F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and H. J. PAYNE. London. Improvements in electrical measuring instruments. February 25, 1888.

2,876. M. R. WARD. London. Improvements in the method and means of working the driving appliances on electrically propelled vehicles. February 27, 1888.

2,883. H. F. RICHARDSON. Teddington. Lighting a lamp from the incandescent wire of a galvanic battery. February 27, 1888.

2,933. H. J. HADDAN. London. Improvements in mechanism for regulating the force of dynamos or magneto-electric generators. (W. S. Hill, United States.) February 27, 1888.

2,956. A. B. HARRIS. Oxford. Automatic electrical fog signalling on railways working in conjunction with the present block system. February 28, 1888.

3,072. H. W. RHOADS and F. W. TICEHURST. Improvements in automatic electric induction apparatus. February 29, 1888.

3,075. A. W. SOUTHEY. London. An improved clutch for regulating feeding rods in electric arc lamps. February 29, 1888.

3,097. B. M. DRAKE and J. M. GORHAM. London. An improvement in holding the plates of secondary voltaic batteries. February 29, 1888.

3,149. L. KAYSER. London. Improvements in galvanic batteries. March 1, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

March 3, 1888.

4,225. G. HOOKHAM. London. Improvements in electricity meters, parts of which improvements are applicable to dynamo-electric generators and motors. March 21, 1887.

5,562. W. MAXWELL. London. A system of generating, reproducing, and distributing electricity. April 16, 1887.

5,709. A. J. GRAVIER. London. Improvements in dynamo-electric machines. April 19, 1887.

5,867. W. KINGSLAND. London. Improvements in secondary batteries. April 22, 1887.

6,294. A. WATT. London. Improvements in the electrolytic treatment of zinc and its ores. April 29, 1887.

PATENTS SEALED.

February 24, 1888.

13,660. D. L. SALOMONS, Broomhill, O. E. WOODHOUSE and F. L. RAWSON, London. An improved combination electrical switch. October 25, 1886.

700. S. ZIANI DE FERRANTI. London. Improvements in electric furnaces and apparatus for heating, lighting and carrying on chemical processes, and in the working of such furnaces or apparatus. January 15, 1887.

15,653. H. H. LAKE. London. Improvements relating to electrical apparatus for signalling in railway trains and to coupling devices for use therewith. (De Mier, Electrical Train Signal Company, Incorporated, United States.) November 15, 1887.

15,730. J. VAUGHAN-SHERRIN. Ramsgate. Improvements in galvanic batteries. November 16, 1887.

February 28, 1888.

8,751. J. G. LORRAIN. London. Improvements in clocks and apparatus for winding the same by electricity. July 3, 1886.

8,896. J. G. LORRAIN. London. Improvements in clocks and apparatus for winding the same by electricity. July 7, 1886.

16,661. R. P. SELLON, W. M. MORDEY and C. E. WEBBER. London. Improvements in self-regulating dynamo electric generators. December 18, 1886.

266. E. EDWARDS. London. Improvements in electric telegraphs. (D. Kunhardt, Germany.) January 7, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

3,225, 1887.—R. DICK and R. KENNEDY. Generating and distributing electric energy, &c. (Price 8d.)

4,032, 1887.—M. IMMISCH. Holder for brushes of electro-motors, &c. (Price 8d.)

4,322, 1887.—J. and E. HOPKINSON. Dynamo electric machines. (Price 11d.)

4,472, 1887.—S. P. THOMPSON. Electro-deposition of cobalt. (Price 6d.)

4,978, 1887.—F. T. SCHMIDT. Holder and switch for electric lamps. (Price 8d.)

4,980, 1887.—F. T. SCHMIDT. Making and breaking electrical circuits. (Price 8d.)

5,009, 1887.—J. T. ARMSTRONG. Secondary batteries. (Price 6d.)

5,092, 1887.—B. EGGER. Switches for electrical purposes. (Price 8d).

5,228, 1887.—W. H. BAYLEY. Holders for incandescent electric lamps. (Price 8d.)

5,707, 1887.—E. F. H. H. LAUCKERT and H. W. KINGSTON. Automatic cut-outs for electric arc lamps. (Price 8d.)

6,972, 1887.—J. C. MEWBURN (La Société Anonyme pour la Transmission de la Force par l'Electricité). Obtaining derived currents of variable intensity from a main electric current. (Price 8d.)

COMPANIES' MEETINGS.

The Anglo-American Brush Electric Light Corporation (Limited).

The seventh ordinary general meeting of this Corporation was held at the Cannon-street Hotel, on the 2nd inst., the Right Hon. Lord Thurlow, F.R.S., presiding.

The SECRETARY (Mr. E. Garcke) read the notice convening the meeting.

The CHAIRMAN, in the course of his remarks in moving the adoption of the report, said : I think you will concur that all that has happened, if not everything in connection with our industry during the past year, has been entirely satisfactory to your interests, and it has convinced me very fully that the affairs of this Corporation rest upon a sound financial and commercial basis. We have now worked at a profit during the whole of 1886-7. During the last twelve months the volume of our business has increased by 23 per cent. over what it was in 1886, and during the same time, owing to economies we have been able to introduce, our net profits have increased by nearly 10 per cent. That I think is a very favourable state of affairs taken by itself, but it is more satisfactory when it is considered by the side of the great fall that has taken place in the prices of electrical appliances of all descriptions. The result of the year's working is to show a respectable balance. We think, however, that we should not be paying due regard to the permanent interests involved if we adopted the course of paying you what I cannot help myself considering as a small dividend. We think it is wiser to keep the money in our pockets in view of the great development we anticipate to take place in the course of the next 12 months in electric lighting generally. We

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therefore hope you will adopt the scheme, which you will find in our appropriation account, of putting £2,500 to what is called provision account, and carrying £2,500 to the account of this year.

Before I go further, however, I wish to say one word on the depreciation of prices in order to bring home to you to what an extent this has occurred, and how greatly it has increased our difficulties. In 1881 the largest class of Brush dynamo we made cost £800. We now make a machine more efficient, more powerful, superior in manufacture, better in every conceivable way for £360, or less than half, and it is only by getting down from £800 to £360 and making a better and more efficient machine that we are enabled at all to compete with other makers. As regards economies we have been aided by our very efficient staff, and thus we have been able to counterbalance this depreciation. I may explain in a few words in what departments those economies have been effected.

First of all we have succeeded at length, after attempting to do so for two or three years, in bringing all our manufacturing processes and all our work under one roof at Belvedere-road, Lambeth. We have been enabled to do that by sub-letting the works in the Borough-road, and by, on favourable terms, renouncing the lease of our works in Portpool-lane. In the second place, we have been enabled to introduce economies by making more favourable contracts for coal, oil, and other things. A third economy we have been able to introduce was foreshadowed in our last report—I refer to the arrangement that has been carried out very efficiently by the negotiations which have been conducted by our assistant secretary, Mr. Fells, with the various railway companies for a reclassification of their rates for the transit of electrical machinery. I have two diagrams which will convey at a glance our position. The first is a little diagram prepared by our ever active secretary, Mr. Garcke; it shows you the upward tendency of our business from 1883 to 1887. The other diagram is a little more complex, but it is no less satisfactory and interesting. It shows the fluctuations in the general charges and the gross profits during the years from 1883 to 1887. Comparing this diagram with the other it will be seen that in 1884 the expenses of management fell from £21,700 to £14,700, concurrently with the increase of business; that in 1885 the expenses rose slighly, but that the business and profits rose in a much higher degree; that in 1886 the expenses fell from £15,800 to £13,800, though unfortunately the volume of business also fell; and that in 1887 the three factors showed an improvement, the expenses being lower than ever, the profits having increased from £13,000 to £16,000, and the volume of business extending to upwards of 50 per cent. as compared with 1886. I think these are figures which any commercial company may point to with pride, especially at a moment like this, when it is almost doubtful whether there is any active recovery of trade.

You may very reasonably desire to have some information respecting our Continental or Austrian business. You are aware how we acquired that business. It was the result of absorbing the International Company, which was really the Anglo-Austrian Company. We absorbed that company last year on favourable terms. We obtained possession of all their assets on terms which you approved at the time, and certainly which I do not think you have had since any occasion to regret. These assets, among others, consist chiefly of two things—the street-lighting installation at Temesvar in Hungary, and the share the International Company held in the firm of Kremenezky, Mayer and Co., electrical engineers and manufacturers, in Vienna. Temesvar really consists of three towns all joined together, and the streets are now entirely lighted by electricity, and have been for some years. It is lighted by mains over thirty miles in length in the streets of the three towns. It is lighted exclusively on the Brush system, and has been in successful operation since 1883. The contract with the municipality is a very favourable one to the undertakers in many respects. The term of the contract is twenty-five years, and at the expiration of that period the municipality can either renew the contract or purchase the works from us at a fair valuation. The lighting of the streets is effected by 700 incandescent lamps. When the Corporation took over that installation it was not quite self-supporting, owing to the expensive manner in which some of the details were managed. Since we have had charge of it, we have appointed a new manager, a very admirable man, Mr. Clements, and he has fully justified the authority that we gave him to deal with matters at first hand. I am happy to be able to inform you that the private lighting along those 30 miles of streets is now almost daily on the increase and is giving great satisfaction, and instead of being conducted at a loss, that installation is now being run at a small profit, but a monthly increasing profit. It also affords what is satisfactory to be able to point to in the present day—an instance of a whole town having adopted the electric light in preference to gas, which was formerly there. The business of Kremenezky, Mayer and Company we have now obtained entire possession of. We paid for the remaining portion of the business a reasonable sum down in cash, and we made an arrangement with Mr. Kremenezky, who is a man of very great energy, to continue the management of the business. The business is an increasing one. It has before it a great field, and I believe substantial profits. The only point I regret about it is that it is essential from time to time that an officer of the Corporation at home should go out to Vienna and see that everything is going on properly. I regret greatly this, because it has deprvied us during the year for a time of the services of Mr. Garcke, whose acquaintance with Germany and the German language has proved invaluable on this occasion. As regards the accounts for the past year of the Austro-Hungarian business, they were not received by us in time to be included in our balance-sheet, but they have since come to hand. An examination having been made of them, there is a profit on the business of the past twelve months.

The report alludes, among other things, to a matter of interest, namely, the largest arc light installation ever done in England—that of the Manchester Jubilee Exhibition last year. It consisted of 600 lamps, which were exclusively on the Brush system. It ran for six months, and it gave satisfaction to all concern. We ran the risk of heavy penalties in connection with that undertaking, and I am happy to be able to tell you that we were not called upon to pay a shilling fine, and at the termination of our contract we received letters from the authorities and the exhibition people congratulating us on the manner in which we had performed the work. We have now undertaken a similar piece of lighting, but of 400 lamps instead of 600, for the Glasgow Exhibition, and I feel confident that we shall give satisfaction there equal to that which we gave at Manchester.

I now come to a subject of great importance, which is known as compound winding, for which we hold exclusive patents. There was some litigation going on last year on this subject. We have every confidence in the strength of our position, and I am happy to say that that position has been recognised by all the leading makers in Great Britain. It is especially satisfactory to us that great firms like Messrs. Crompton, and others, while they felt it their duty of course to oppose our claims, have behaved most honourably in this matter, and they took licences and agreed to pay royalties. In place of any soreness now existing between us and them on account of the threatened litigation with them on that subject, I am happy to say that the matter has brought us nearer together. We consider that we have established our position in regard to compound-winding machines in Great Britain, and that no machine can be made on this principle in future without being subject to a moderate royalty to us. There is only one firm that contests our right. We do not regard their action as of any importance.

There are subjects of technical importance to which the attention of our staff has been directed during the past year. Electric science, as you know, has not yet reached perfection or maturity. It is necessary to follow the progress made in the laboratory very closely in order to keep in the forefront of manufacturers of this class of goods. It is for this reason that you will find in our account every year a sum devoted to what we call developments of various patents and further improvements and inventions, without which we should fall into the background. We are now making alternate-current machines under an entirely new design. We have also patented a new type of transformer for transferring high tension into low-tension currents, and *vice versâ*.

We have introduced into our establishment a bonus scheme for admitting the principal officers of our staff and the heads of departments to a participation in our profits. We did not adopt a scheme of that kind without much consideration. It is nothing new; it has been adopted by very many of the largest firms in the kingdom, and successfully adopted. We feel that it is the right principle, and we have, after mature consideration, adopted it subject to your approval. The deduction that it will entail from your profits is more nominal than real, for we have proved to our satisfaction that it does not amount to a deduction from your profits but to a small percentage of the economies effected, which go into the pockets of those persons through whose instrumentality alone we can effect these economies.

I should now like to draw your attention to a few figures which are very striking in the balance-sheet. In connection with the first item on the credit side of the balance-sheet I do not wish to shirk the least responsibility. I refer to the figure at which our patents now stand, £57,674. I am bound to say that, knowing what these patents cover, I consider that that figure is an eminently satisfactory one, one that I can regard with the most perfect equanimity. You must remember that in 1882 your patents stood at £179,468, and since then they have been written down to £57,674. And not only that, but you must remember that we have acquired the Brush licenses for the metropolis, for the provinces, for the Continent, and for British India, with the exception of Hyderabad and Bombay. In addition to that we have acquired new patents, to some of which I have referred, and our patents are more valuable than in 1882, while they stand at between a third and a fourth of the amount. The next figure is the item of our property, £82,737. That is a figure that will also bear any examination, representing, as it does, property which, if it were realised not suddenly but with common prudence, would give you a very good return for the figure at which it now stands. You must also bear in mind that there is provision made for any shortcomings to the extent of £14,000, which amount, if you adopt this balance-sheet, will be increased to £16,500. Then I come to the question of debtors and creditors. Last year we owed our tradesmen on current account £12,848; this year, notwithstanding that we are doing more work, that our establishments are much more busy, and that our contracts are much heavier, we owe our tradesmen less by £500. On the other hand, the money due to us, which is all good, was last year £30,600, and this year it is £45,600, or 50 per cent. more.

There is now a point I must refer to which I had hoped General Webber would have been here to speak on to-day—the City lighting. As you know, the negotiations we have been conducting with the Commissioners of Sewers have been pending for several years. We have been going on patiently, and we have met the Commissioners of Sewers with every attention. The negotiations are not, I am sorry to say, sufficiently complete to enable me to tell you that they are final, but, at the same time, I have every conviction in my own mind that after the length of time these negotiations have been going on and from the close point at which we have now got them, there can be but one result from them, which is acceptance of our offer. Under that contract we should have to deposit £1,000 in the first instance, which we are to forfeit entirely if we do not begin to work within a very few months after the signing of the contract. Sufficient guarantees are also placed in the hands of the Commissioners of Sewers to completely cover any risk that may be run from any undue temporary monopoly we may acquire under the contract with them for the private lighting. In fact, the Commissioners of Sewers very properly have seen fit to surround the contract that is to be given to us or someone else with every conceivable precaution in the interests of the public. If we get that contract we shall do our utmost, and I feel confident we shall succeed, to execute it satisfactorily. But it will not be a contract

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from which directly we shall obtain enormous profits, or, in fact, anything more than the fair and reasonable tradesman's profits. That is my view of it. Indirectly, of course, it would benefit us. We have within the last few days received letters addressed to us spontaneously by some of the largest firms in Great Britain expressing their sympathy with us at the wearying delays connected with these negotiations, and hoping that they may not be much longer protracted, as they are so detrimental to the electric lighting industry generally.

The noble Chairman then referred to the Bill pending in Parliament promoted by the South Eastern Railway Company, one of the powers sought by which measure being to acquire the premises of the Corporation, or part of them, in Belvedere-road, Lambeth. He stated that after great difficulty they had at length got their works and business concentrated under one roof, and they must be subjected to inconvenience whatever portion of their premises might be required to be taken by the railway company. The Corporation were not exacting in their demands, and he believed they would bring the railway authorities to a sense of the justice of their demands for reasonable compensation for taking their premises, or any part of them.

Speaking of the litigation with the Edison and Swan Company he continued: I did not intend to say a single word on this subject, for I am one of those who accept the doctrine that there is an unwritten law and very proper custom not to discuss any matter of this kind that is actually before the Courts. I do not think that it is right to do so. As, however, that view of the case was not taken the other day by Mr. Forbes when he addressed his shareholders at the Swan meeting, I hope you will pardon me if I also ask your permission to say a few words. I have not a word to say against what fell from the lips of Mr. Forbes as regards ourselves. He spoke courteously, I am told, of the Corporation, and especially went out of his way to say that the term "rascally infringers," of which he had made use, was not intended to apply to us, and that he did recognise that we possessed certain patents. Well, that is very good of him, and I think no one knows better than Mr. Forbes that we do possess patents. I desire to assure you that if this matter has gone into court, and is to be decided by the Court, it is owing to no fault of ours. We have approached Mr. Forbes's company at different times, and made every proposal to him that we felt we could properly make as the custodians of your patents, rights, and interests. If an arrangement has not been come to, I cannot admit for a moment that it is owing to any neglect on our part of what we might reasonably be expected to have done in this matter. We are advised by our counsel and by some of the greatest experts and most powerful technical minds in the country that we have not only a good case, but an overwhelmingly strong case. We are armed at all points, and are ready for the fray. We face the position forced on us not only with equanimity but with perfect satisfaction and confidence. Whatever the result of this litigation may be it can hardly fail, if thrashed out in the courts of law, to weaken or completely break down those bars for some years to come to the flood of unscrupulous and ignorant promoters to which at present the free trade in electric lighting would and inevitably must expose the ordinary householder. Finally, you must remember that this action, be the result whatever it may to us, affects only one portion of our business; while to the Edison and Swan Company defeat probably means ruin.

Before I sit down I desire to take this opportunity to thank one of the best known men in the City, the able and indefatigable secretary of the Stock Exchange, Mr. Burdett, for sending to me, as he courteously did, a copy of his invaluable work, "The Official Intelligence for 1888," and I wish to draw your attention to one of the introductory chapters in this year's volume, on the early history of gas lighting, for you find detailed the difficulties gas lighting met with at its introduction in the early years of the century. You will find reference made to the hopeless struggle which the introducers of the gas industry met with for fifteen or twenty years. How hopeless it seemed at that time can only be gathered from reading these pages, and that was even in the absence of the legislative restrictions to which we are exposed. The promoters of the gas industry found that it took twenty-five years before they could work at a profit, and even then it was only by the original shareholders two or three times sinking and absolutely losing every farthing they had invested in the undertaking. I know as much as most people how much money has been lost in introducing the electric light, but I am thankful to say that by the study of these pages you will find that not a fourth of the money has been lost, sunk, or thrown away on the introduction of the electric light compared with what was sunk, lost, or thrown away in introducing gas light; and so far from taking twenty-five years to make it pay, I do not like to prophesy, but I venture to say that from twelve years from the introduction of the science, in 1880, there will not be a gas lamp in the streets of any town in England. He concluded by moving the adoption of the report and accounts.

The Vice-Chairman (Mr. J. S. Sellon) seconded the resolution, and briefly alluded to the rapid progress of electric lighting in America, and the encouragement it should afford to those engaged in the same work on this side.

Mr. Hart inquired whether arrangements had been made to take other premises in the event of the railway company wanting the works. In regard to the litigation between the Company and the Edison and Swan Company, were not the Company in the position taken up by Messrs. Woodhouse and Rawson in the late actions between that firm and the Edison and Swan Company? The number of the Directors was less, but he noticed that the fees were the same—£1,500—which he thought rather heavy, seeing that the Company were not paying a dividend.

Mr. Weir, as an original shareholder, expressed satisfaction at the progress which had been made. The chairman had predicted that in twelve years from 1880 every street lamp in England would be lighted with electricity and not gas, but the gas companies admitted that the street lighting was not very profitable to them. What was wanted was to get the domestic lighting. He was glad to gather that the litigation was not so serious as one would imagine from reading the speech made by Mr. Forbes the other day. He thought that the stock on hand was rather too large. He quite understood the view of the Chairman that every shareholder in electric light companies should read the article referred to in Burdett's "Official Intelligence."

Mr. Stobart thought that it would be advantageous if there were one or two commercial men on the Board, which he noticed was composed almost entirely of scientific men.

The Chairman, in reply, repeated that the subject of a possible removal to other premises was receiving careful consideration and attention, but they could not commit themselves to taking new premises until they were turned out of their present buildings. It was uncertain what portion of their premises the railway company wanted. As regards the litigation, he would ask Mr. Renshaw to say a few words, following the example of Mr. Forbes at his meeting, in desiring Mr. Crisp to address his shareholders.

Mr. Renshaw said he quite agreed with Lord Thurlow that it was not desirable to discuss a matter as to which litigation was pending; but as for the reason stated by his lordship he had been called on to address them, he might point out the exact position of the litigation. He might first state that the Brush Corporation did not seek the litigation, which was forced on them by the Edison and Swan Company. The Company then looked at their own patents and discovered that every Edison lamp made by the other company infringed one of the Brush Company's patents, and that every Edison lamp used in connection with storage batteries infringed another of the Brush Company's patents, the Lane-Fox. They commenced a cross action against the Edison and Swan Company, respecting which they had been assured by the most competent counsel and the most able experts that they would succeed. With reference to the action of the Edison and Swan Company against the Brush Corporation with respect to the lamp, it was practically re-trying the case of Woodhouse and Rawson, but it was re-trying it with fresh evidence, which made them feel sure as to the Edison patent, and with respect to the Cheeseborough patent they also felt that they would have perfect success.

The Chairman then put the motion and it was carried unanimously, the retiring Directors and auditors being subsequently re-elected.

On the motion of Mr. Weir a hearty vote of thanks was passed to the Chairman and Directors.

The Telephone Company of Egypt (Limited).

The fifth ordinary annual general meeting of this Company was held at the offices, Austinfriars, last Tuesday, under the presidency of General Alexander Fraser, C.B., R.E.

The Secretary (Mr. Alexander B. Chalmers) read the notice convening the meeting, and the report of the Directors was taken as read.

The Chairman said: I think that as shareholders we may look upon the position of our Company at present as being favourable. Starting in 1883, we paid for the first year 2½ per cent. on the preference shares; in 1884 we paid 3 per cent., in 1885 5 per cent., in 1886 6 per cent., and now, for the last year, we propose a similar dividend. After writing off a considerable sum for depreciation we carry forward an amount practically equal to about 1 per cent. on the preference share capital. Our gross business has increased by quite 50 per cent. since we started, and I am glad to say that our working expenses have not increased in anything like the same proportion. For this happy feature in our business—that is, the economical working—we were greatly indebted to the late manager, Mr. A. D. Evans, whose death in our report we very much deplore. We have appointed his son, Mr. W. N. Evans, to be the manager of our business in Egypt. We thought if we could, compatibly with the interests of the Company, appoint Mr. Evans' son to the management of the business, it would be a fitting tribute to the excellence of his father. We made due inquiry in the matter. He was strongly recommended by the leading merchants and bankers in Egypt. He had been under the tuition of his father for some time, and the chief agent in India of the Oriental Telephone Company being on his return to that country, we asked him to report on the general management by this young man. I am happy to say that this report was very favourable. Under those circumstances we had no hesitation in appointing Mr. W. N. Evans in place of his father to the management of the business in Egypt. However, Mr. W. N. Evans is a very young man, and we took advantage of the offer of three gentlemen in Egypt of first-rate position, who volunteered their services to form themselves into a committee to discuss matters of importance with the manager. Those gentlemen have formed themselves into that committee, and we anticipate successful management through this arrangement. We are glad to report that, so far, our new manager gives evidence of that cautious and economical management which was so distinctly shown by his father. I am glad to be able to state that since we made our report the extension of our business to Helouan, which is about sixteen miles from Cairo, has been completed, and we expect a large business from that connection. You are aware that there is considerable competition in Egypt in all business, and it is necessary that we should provide means by working capital whereby we may be able to utilise the concessions which we have obtained from the Government, and after consulting our principal shareholders we came to the determination to ask you to pass a resolution to-day to extend our borrowing powers from £5,000, as at present limited, to £20,000, and we propose to create debentures to that amount, of which we intend a present issue of £10,000 only. Of this sum a portion will be required to pay off a loan that we have from the Oriental Telephone Company and the remainder will represent the working capital of the Company. It would not be consonant with good

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policy to let any chance slip of increasing our business by reason of any delay in having to ask you for the means to carry out any extension of our business, and it might not prove convenient to the Oriental Company to continue the loans, from which we have hitherto derived great benefit at a moderate interest. You will observe that, including the above loan now to be paid off, we have spent about £10,000 on new constructions over and above the capital issued for the acquisition of the business as a going concern, and as this total value now represents £70,000, on which we are earning some 6 per cent., we think with such security the investment in our debentures at 6 per cent. will be undeniably a good one, and we ought not to have any difficulty in placing these debentures. You may, perhaps, ask why we carry forward so large a sum as £665, which represents 1 per cent. on the preference capital; but you will observe that while our gross business has extended some 50 per cent., the mean value of each subscription has decreased, and we have therefore thought it safer to carry forward a substantial sum. The decrease in the rate of subscription, of course, popularises the convenience which the telephonic business represents to business men, and it will be satisfactory if it be more than counteracted by the extension of our system. I do not think that I have anything more to say, but before proposing the resolution I shall be very happy to answer any question. No question being asked, however, he continued: I move—

"*That the report and accounts be received and adopted, and that a* "*dividend of 6 per cent. per annum on the preference shares be paid on* "*13th inst., free of income tax, and to be applied as stated in the report.*"

Mr. HENRY GREWING: I beg to second that.

The CHAIRMAN put the motion in the usual way, and it was carried unanimously. Continuing, he said: Then, in regard to what I said just now with reference to the debentures, I have to move—

"*That, in accordance with Article 60 of the Articles of Association,* "*Sub-section A, the Directors be and they are hereby authorised to raise* "*money by the issue of debentures to an amount not exceeding £20,000.*"

Mr. W. ADDISON seconded the motion, which was carried unanimously.

The CHAIRMAN: By the Articles of Association one of the Directors has to retire, but being eligible he offers himself for re-election. I am sure, as Chairman, that it is not possible to find any gentleman who, by his attention to the business and ability to consider what is best for your interests, would equal Mr. Grëwing, and therefore I feel confident that you will not fail to elect him.

Mr. THOMAS LLOYD seconded the motion, which was unanimously passed.

Mr. GRËWING: I thank you very much, gentlemen, for re-electing me.

Mr. ADDISON: I beg to propose—

"*That Messrs. Price, Waterhouse and Co. be and they are hereby re-*" *elected auditors of the Company for the year 1888, and that their remu-*" *neration for that period be the sum of 15 guineas.*"

Mr. J. L. BYLES seconded the motion.

The CHAIRMAN having intimated that that closed the business of the meeting,

A vote of thanks was passed to the Chairman, on the motion of Mr. ADDISON.

The CHAIRMAN: I am very much obliged to you for this vote of thanks, which I accept as due as much to my colleagues as to myself, and probably more so. I am sure that we shall attend in the future to the business before us, and I hope we shall always be able to give you at least as good a report as we are enabled to present you with this time.

The meeting then separated.

CITY NOTES, &c.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of February was 4,528, estimated to produce £3,600, against 3,822 messages, producing £3,009, in the corresponding month of last year. The traffic receipts for the month of November, 1887, estimated at £3,000, realised £2,998.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for February, 1888, amounted to £1,858, against £1,623 in the corresponding period of last year.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for February amounted to £20,400, from January 1st to February 29th to £41,800, comparing with £39,600 and £38,680 in the corresponding months of 1887 and 1886 respectively.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this company for the month ended February 29th, 1888, amounted to £4,625.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this company for the week ended March 2nd, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,766.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, March 7, 1888.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending March 7, 1888. Highest.	Lowest.
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,860	Stock	10/0	Anglo-American	40 41	3 6 3	Jan., Apr., July, Oct.	40½	40
2,614,820	Stock	20/0	Do. Preferred	65½ 66½	4 1 5	" "	66¾	66½
2,614,820	Stock	nil.	Do. Deferred	14 15	...	February	...	...
130,000	£10	3/0	Brazilian Submarine	11¾ 12	5 16 8	Mar., June, Oct., Dec.	12	11 15/16
16,000	10	8/0	Cuba Submarine	12¼ 12¾	6 6 0	February and August	12¾	12⅝
6,000	10	10/0	Do. Preference	18 19	5 5 3	" "	18½	...
			Direct Spanish	3¼ 3¾	...	...	3¾	...
6,000	5	5/0	Do. Preference	8¼ 9¼	...	April and October	...	...
60,710	20	2/0	Direct United States	8⅝ 8⅞	4 8 0	Jan., Apr., July, Oct.	9	...
380,000	10	2/6	Eastern	11⅝ 11⅞	4 16 9	" "	11¾	11⅝
70,000	10	3/0	Do. 6 per Cent. Preference	14¼ 14¾	4 1 4	" "	14⅝	14⅝
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 0 0	February & August	...	...
250,000	10	2/6	Eastern Extension	12 12½	4 17 6	Jan., Apr., July, Oct	12 5/16	11 15/16
22,050	10	5/9	German Union Telegraph and Trust	8¾ 9¼	6 9 9	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅝ 5⅞	4 18 0	Jan., Apr., July, Oct.	5¾	5⅝
178,992	10	3/0	Do. 6 per Cent Preference	13⅜ 13⅝	4 8 0	" "	13⅝	13 7/16
150,000	10	5%	Great Northern	13¾ 14¼	5 5 6	Jan., July, and April	13⅞	...
17,000	25	5%	Indo-European	38 40	6 5 0	April and October	39	...
			London Platino Brazilian	5 5½	...	...	...	...
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October	...	...
338,225	Stock	15½%	Submarine	135 145	9 9 0	February & August	140	...
30,000	10	6/0	West Coast of America	5¼ 5¾	8 13 9	January and July	...	...
			Do. Debentures	111 116	...	...	...	...
88,321	10	nil.	West India and Panama	⅝ ⅞	...	...	11/16	...
34,563	10	9/0	Do. 1st Preference	9½ 10	7 10 0	April and October	10	9¾
45,181	15	3/9	Western Brazilian	9¼ 9½	8 12 9	March & September	9 7/16	9 5/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds ...xd	98 101	6 0 0	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	9/16 11/16	5 9 0	Yearly	11/16	⅝
			Oriental		...	...	...	...
80,000	£5	5/0	United	13¼ 13¾	4 16 3	June and December	13⅝	13⅝
			United River Plate	4¾ 5¼	...	...	5	15/16
			ELECTRIC LIGHT.					
	5		Anglo-American Brush (£4 paid)	2¾ 3¼	...	...	3⅛	2⅞
23,692	5	nil.	Do. (fully paid)	3¾ 4¼	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅜ 2⅝	...	...	2½	2¼
312,000	¼	5% '87	Maxim-Weston	⅛ ¼	...	February	3/16	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance ...xd	38 40	6 1 3	March and July	39½	38½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works xd	15 17	5 17 8	February & August	16¼	16⅛

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

The effect of the Postmaster-General's announcement disclaiming any intention of purchasing the telephone systems has been rather the reverse of reassuring. In several quarters, chiefly financial, but including some technical journals, the advice given to the companies is to "go ahead," ostensibly in order to enlarge their property so as to increase its value when the time comes for selling it, but really, as it seems to us, to make things so unpleasant all round that the interval between now and the date of sale shall be shortened in spite of Mr. Raikes. The cynical, not to say unscrupulous, language in which this advice is couched ought to make the companies pause before accepting it. In plain words it means simply this—enlarge your capital, and let us all have a share in the good time which is sure to come sooner or later. The companies are even egged on to increase their overhead wires to an insufferable extent, until the public compel the Government to take them under control. All this may be very smart, but it is not business; and our own advice would rather be to go on as if nothing had happened or were going to happen; and, above all, to lay out no money except for money's worth. Depend upon it, whenever the time does come for incorporating the telephone system with the telegraph, the Government will not pay for worthless plant or speculative extensions of the kind recommended. All the same, we consider the situation highly unsatisfactory, and hope that the serious attention of Parliament may soon be directed to it.

The terrible storm which visited the Northern States of America on Monday and Tuesday last will furnish additional, though not fresh, arguments for the adversaries of overhead wires. It is already evident from the imperfect accounts which have yet arrived that the greater portion of the overhead-wire system within reach of the blizzard has been completely destroyed. Our recollection of the condition of the London streets in the early days of last year probably enables us to form only a very faint picture of the spectacle which must now be presented by the streets of New York—and probably, also, of many other towns from Boston to Philadelphia. The occasion is not one, however, for useless reproaches or ill-natured remark of any kind. Our American friends are face to face with a calamity which they have always known to be possible, and which the Board of Aldermen, of New York, have long been endeavouring to avert. Unhappily—and this is where the dilemma arises—notwithstanding the large sums already expended and the rigorous exercise of the powers at their command, the Board have not been very successful in their attempts to solve the difficulty by placing the wires underground. The present disaster will no doubt lead to renewed efforts in this direction, and we still entertain a belief in their ultimate success. Meanwhile our American friends, while re-erecting their overhead lines, will no doubt follow the example set last winter in this country, and take the opportunity to strengthen their supports, increase their struts and stays, and shorten their spans.

Without, however, going to America the English press have taken hold of the comparatively harmless storm which swept over these islands about the same time as New York was being buried in snow and its property destroyed by the wind. Some lines were interrupted for a few hours in the West of England, and in the metropolis, as well as in some provincial towns, several telephone wires came to grief. Accordingly we are again reminded that these abominable contrivances not merely disfigure our streets, which they certainly do, but that they darken the air and decapitate the foot-passengers, which fortunately they do not do. Even by the great storm in the States we hear of no injury to persons inflicted through falling wires.

Our New York Correspondent gives a very interesting summary of the proceedings of the American Electric Light Association, at Pittsburgh. The papers were, as a rule, of the usual practical character, embodying the results of experience in arc and incandescent lighting on a scale which is unhappily quite unapproachable in this country. We would particularly call attention to the excellent paper by Mr. Church (which we reprint in this issue), on the question of engine power. Mr. Church brings forward evidence of a very powerful character in favour of independent engines belted direct to the machines. The question is one of considerable and immediate importance to the electric lighting interest in this country, and if any good reasons can be adduced on the other side we shall be pleased to hear them. The only paper on electric motors was of a somewhat disappointing character. The author dealt chiefly with the theory of motor construction, but as Mr. Reckenzaun pointed out in the discussion his formulæ were not of much practical value. No meeting of this Association would be considered a success without the participation of that learned, witty, and ever-charming scienticulist, Dr. Otto Moses. The Doctor first achieved distinction in the scientific world many years ago by his proposal to employ

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solidified hydrogen for incandescent lamp filaments. That the brilliancy of the learned doctor's scientific imagination is still undiminished may be gathered from an observation recorded on page 466 of our last issue.

On the whole the account we gave of the reception of Lord Thurlow's Bill in our last week's issue continues to be true, the gas-lighting journals, as well as the political organs, speaking of it in terms which, at all events, are fair if not always friendly. The one exception which has come under our notice is in the pages of *Money*, whose violent abuse and personal insinuations, however, are discounted by the ignorance it displays of the subject under discussion. The arc light is quite as dangerous as gas, according to this authority; and neither the arc nor incandescent lamp is of any use when there is a fog. It is satisfactory to note, nevertheless, that the gas companies are advised to offer their customers the choice of these dangerous and useless means of illumination as against gas—in other words, to take up with the business of electric lighting in order to ward off a competition which is admitted to be dangerous. It is alleged in support of this suggestion that the gas corporations possess already the powers to open up streets, and if they choose "could even run the wires through their existing mains." We are not quite so sure about these powers being applicable to the purposes of supplying electric light, the gas companies, so far as we know, not being exempt from the conditions imposed under the Act of 1882. But we gratefully accept the heroic proposal as, at all events, a testimony to the harmlessness of electric lighting wires, whatever may be said of the lamps. For our part we shall be quite content to let the lamps take care of themselves whenever we have made safe provision for the conductors.

Dr. Oliver Lodge showed a very pretty experiment at the Society of Arts on Saturday last. It is not absolutely new, although many of our readers will probably not have met with it before. When a stick of sealing wax is rubbed on the coat-sleeve and held near a small jet of water which rises to the height of two or three feet, the drops, instead of breaking into fine spray at the summit of the jet, immediately coalesce, and fall almost in a single stream. The effect is very marked, and must be due to the most minute traces of electrical action, since the rubbed wax may be presented two or three feet away from the jet. This experiment may be held to account for the fact that thunder showers usually consist of large drops, but the *modus operandi* is by no means clear. The experiment is, we believe, due originally to Lord Rayleigh.

The lecture was of a most interesting character throughout, and we strongly advise all who have the *entrée* not to miss the second and concluding part, which will be delivered to-morrow afternoon, at 3 o'clock. Dr. Lodge has promised on that occasion to show some new experiments, which will tend to throw light on some of the more obscure phenomena of thunderstorms, and particularly as to the reason why lightning flashes sometimes strike conductors elsewhere than at the top of the rod, and sometimes leave the rod before descending to the earth. The experimental evidence may also be expected to decide the vexed question of iron *versus* copper for lightning conductors. We venture to anticipate a verdict in favour of the latter material.

Our knowledge of electric meteorology, though still lamentably meagre, is certainly making progress. Next week we shall have the Exhibition of Electrical Apparatus by the Royal Meteorological Society. In connection with this display a paper is to be read on the 21st inst., by Mr. G. J. Symons, F.R.S., "On the Non-Existence of Thunderbolts; Elucidated by Accounts of Searches after Them, and the Exhibition of Specimens." It may at first sight sight appear that the argument for the non-existence of thunderbolts will not be greatly strengthened by the exhibition of specimens, but Mr. Symons probably thinks that what is lost in point of consistency is gained in interest, and, perhaps, he only intends to exhibit "reputed" specimens. We do not think, however, that there is any great difficulty in proving the negative, because there are two positive facts which seem amply sufficient to account for the origin of the thunderbolt myth. These are the well-established phenomenon of globular lighting and the entirely independent phenomenon of the fall of meteoric stones.

We understand that negotiations have been opened between the United Telephone Company and the Board of Works which may result in the introduction of a Government Bill for the regulation of overhead wires. The various Metropolitan Vestries have this week been taking counsel together with regard to united opposition to the Telephone Company's Bill.

The Primary Battery—"cheaper than gas"—electric lighting boom still flourishes in perennial vigour. The following is from a leading article in an important provincial journal. After an opening flourish we learn that "Mr. O'Keenan has devised an automatic primary battery, easily portable, which is capable of supplying any number of incandescent lights without waste of any kind. The battery need only occupy a few square feet of space, it is provided with accumulators which store up every particle of electric force not used, and it needs no further attention than that of feeding daily with a scoopful of sulphate of copper. Messrs. Tongue and Birkbeck, who have charge of the patent for this country, assure me that under Mr. O'Keenan's system electric lighting will become little more expensive than gas lighting, and a number of capitalists who have seen the inventor with a view to speculation have expressed themselves highly satisfied with it." We know nothing of Mr. O'Keenan's battery, which may be a highly respectable battery when suitably employed, but we are quite sure that the satisfaction of the capitalists, who have seen the inventor with a view to speculation, will not be of long duration if they plunge in on the faith of the statements advanced in this article. Perhaps, however, it was the inventor who has seen the capitalists "with a view," &c., in which case less harm may be done.

The amount of attention which is now being given to problems connected with alternating currents is very great. In

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the present issue, in addition to a specially interesting chapter of Dr. FLEMING'S "Notes on Alternate Currents," there will be found a communication of considerable importance from Professors AYRTON and PERRY, on the influence of magnetic lag in transformers. We would also call attention to the remarks which will be found in a review of a pamphlet on a wattmeter designed by Messrs. GANZ and CO. The self-same error therein pointed out has more than once been perpetrated by writers in this country, and arises from an incomplete apprehension of the conditions of a circuit with parallel branches traversed by an alternating current.

WE have examined with much interest the portable reflecting galvanometer and lamp designed by Mr. G. L. ADDENBROOKE, and exhibited by him before the Physical Society last week. The need for a portable reflecting galvanometer which is really reliable and easily set up has long been felt. In Mr. ADDENBROOKE'S instrument these features have been combined in a very ingenious and successful manner. A full description will be found further on.

Manchester.—The Royal Botanical Gardens at Old Trafford are to be lit by electric light during the coming season.

Nancy.—The transformer installation carried out by the Edison Company in this town is now working well, and gives great satisfaction.

The Antilles Cable.—The first section of this cable, between St. Domingo and La Guayra, has been successfully laid, and the section between St. Domingo and Curaçoa is now in hand.

Gorlitz, Austria.—Messrs. Siemens and Co., of Berlin, have tendered for the construction of a central station at Gorlitz. Motive power to the extent of 500 horse-power is to be provided. The total cost is estimated at 625,000fr.

Manchester.—The office of the *Manchester Evening News* is now connected with London by a private wire. This is the first private wire which has been established between the metropolis and the office of a provincial evening newspaper.

Vessels for Sulphuric Acid.—The Benardos process (see *Electrician*, Nov. 25th, 1887) has been applied with success to the coating of thin iron vessels with lead, both inside and outside, in order to contain sulphuric acid. These vessels are said to be cheaper than those at present in use.

The Vevey-Montreux Electric Tramway.—This line which runs alongside the Lake of Geneva, and is about eight miles in length, is now complete. A successful trial trip has just been run over the whole length of the line. The engines are at Montreux, and by means of transformers electric light is provided from the same station.

Theatre Lighting in Russia.—The Odessa Theatre has recently been supplied with electric light by means of Zipernowski transformers. The current is brought from a central station at a distance of over a mile. The work has been carried out by M. Ganz and Co., of Buda-Pesth. The same firm has recently lit the Riga Theatre.

The Telephone in Italy.—The following statistics are derived from an official source, and are brought down to a recent date. The telephone is now in use in 49 towns in Italy, the total number of subscribers to exchanges amounts to 9,600, in addition to which there are 470 private lines. The Government derives from this source a revenue of 171,000 lire per annum.

Fire Alarms at Barcelona.—A correspondent writes from Barcelona :—"It may be of interest to you to know that Messrs. Spagnoletti and Crookes, of London, have acquired the contract for fitting up the whole of the extensive buildings for the forthcoming Barcelona Exhibition with their patent electrical fire alarms, which at the close of the Exhibition will be adopted and applied throughout the city."

Messrs. Gent and Co's. Price List.—This list of "general electrical accessories" is prefaced by some very useful and practical instructions for the erection and maintenance of electric and pneumatic bells, including details of wiring (with diagrams) and the management of batteries, &c. The catalogue and price list is very fully illustrated, and the information given is more detailed and more useful throughout than is generally to be found in publications of this class.

Suakim.—The Eastern Telegraph Company's repairing ship "John Pender" reported "all well" at Suakim when she repaired the cable, which was broken about 100 miles from that place on the evening of the 14th. For a few hours the cable worked perfectly, but singularly enough it broke again on the morning of the 15th, about 100 miles further on. The "John Pender" will proceed at once to repair it, and another of the company's ships—the "Mirror"—is to-day at Suez on her way to Suakim.

Paris Exhibition, 1889 (British Electrical Section).—We desire to remind intending exhibitors of the meeting which has been convened by the Council of the Society of Telegraph-Engineers and Electricians for Monday next, the 19th inst., at 3 p.m., at the Institution of Civil Engineers, 25, Great George-street. We understand that Mr. J. Aylmer, the Society's Honorary Secretary for France, will attend the meeting, in order to afford any detailed information required.

The Paris-Brussels Line.—The attempts of the authorities at Brussels to effect communication between the Paris trunk lines and their ordinary subscribers by means of translators do not appear to have been successful. It has now been officially notified that those subscribers who wish to take advantage of the Paris line may have a wire return established (instead of the present earth return) on payment of an annual charge, which will not in any case exceed 50 per cent. beyond the rental at present paid.

Telegraphic Communication Interrupted.—The severe storm of Sunday last made its effects felt throughout the country. Telegraphic communication was interrupted in many places, and at noon on Monday the Post Office gave notice of delay on messages to Exeter and all western offices beyond, and also both to the Channel Islands and South Wales. At a later hour of the same day the postal telegraph authorities were, however, able to issue a notification cancelling the notice of delay previously given.

Trades Unionism.—We have received the following from Messrs. R. E. Crompton and Co. :—"Messrs. Crompton have been informed that it is the intention of the Trade Union not to allow piecework to be introduced into any of the new trades such as they consider electrical engineering to be, and under these circumstances the Company have no option but to part with such of their men who are members of the union. The affair is one of considerable interest to the whole of the electrical engineering trade."

Sales of Plant.—We would call the attention of our readers to two important sales of electrical plant, which are announced in our advertising columns for the following week. On Mon-

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day next Messrs. Wheatley Kirk, Price and Goulty will sell the surplus plant of the Elieson Electric Company, who are moving their works to their locomotive station. On the following Wednesday a large stock of primary batteries will be disposed of. This last sale offers a chance to amateurs and others which should not be missed.

Tubular Magnets.—In the last issue of the *Bulletin de la Société Belge d'Electricien* M. Ernest Gérard has a note on tubular magnets. He points out that if a ring of soft iron of the same section as the magnet itself be laid on the top of the tube, so as to be in contact all round, it is held less firmly than is the case when it merely stands on edge, although in the latter case contact is made at only a single point. M. Gérard thinks that this result can be explained by considering the distribution of the lines of force in the field.

Multiple Synchronous Telegraphy.—In the year 1875 M. R. Kœnig constructed a variable tuning fork which could be adjusted to different rates of vibration. This was effected by making both the stem and the prongs of the fork hollow, the stem terminating in a closed vessel containing mercury. By means of a piston the mercury could be forced up into the hollow of the fork, and thus diminish its rate of vibration. This principle M. Neeren proposes to employ for the adjustment of the vibrating reeds employed in synchronous telegraphy. He has constructed an instrument on these lines which seems to have been successful.

Theatre Lighting by Gas Companies in France. — At Clermont-Ferrand the gas company has just completed an installation of electric light in the theatre of that town. Motive power is furnished by a 16 horse-power Otto gas engine; an Edison dynamo and a set of accumulators are employed. The total number of lamps is only 130.—At Beziers the gas company has also undertaken to light the theatre by electricity.—At Montpellier the Municipal Council has applied to the gas company to supply electric light for the theatre, but the parties were unable to agree upon terms. Negotiations are now in progress with M. Popp.

A New Thermo-Electric Element.—*L'Electricien* says that M. Heimel has constructed a new thermo-electric element having an E.M.F. of 0·18 volt, with an internal resistance of 0·009 ohm. Our contemporary does not say what metals have been employed nor at what difference of temperature the E.M.F. has been obtained. We give for comparison the E.M.F. *per degree centigrade* of the following metals as determined by Latimer Clark:—Clamond's alloy (antimony and zinc) and iron, 0·0102 volt; antimony and bismuth, 0·0102 volt; German silver and iron, 0·0102 volt; platinum and iron, 0·0011 volt; copper and iron, 0·0006 volt.

Lighting of ss. "City of New York."—An important addition will shortly be made to the fleet of Transatlantic liners by the launch of two new vessels built by Messrs. Thompson for the Inman Company. The first of these is to be named the "City of New York," and is to be launched during the present week. In point of size, safety, and comfort this vessel will surpass anything at present afloat. The electric lighting installation is also, we believe, the most extensive ever placed on ship-board. The total number of incandescent lamps exceeds 1,000, and both engines and dynamos are duplicated. The work has been carried out by Messrs. King, Brown and Co., of Edinburgh.

The Barcelona Exhibition.—At the request of the Secretary of State for Foreign Affairs, the Society of Arts has undertaken to promote the interests of the exhibition in this country, and to act as the intermediary between British exhibitors and the executive of the exhibition. The exhibition is announced to be opened on the 9th April, and the date for the receipt of applications from foreign exhibitors has already passed. A request for an extension of the time has been made to the Spanish Executive. In the meantime, British manufacturers who wish to take part in the exhibition, and have not already sent in applications for space, may apply to the Secretary of the Society of Arts, John-street, Adelphi, W.C.

The Lighting of the City.—At the last meeting of the Commissioners of Sewers Mr. H. H. Bridgman submitted a report from the Streets Committee, recommending that the proposed contract with the Brush Company should not be further proceeded with. He explained that it was not intended to shelve the question of lighting the City by electricity, but it had been decided to consider the proposals brought up at the last meeting of the Commission as to other companies doing the lighting cheaper. Mr. J. C. Bell protested strongly against the report of the committee. The report, was, however, adopted, Mr. Bridgman assuring the Commissioners that no time would be lost in bringing further propositions before the board.

Kensington.—At the last meeting of the Kensington Vestry a communication was read from the secretary of the Notting Hill Electric Lighting Company, inquiring whether it is probable that the vestry will shortly notify their assent to the undertaking of the company, as they feel sure that not only their undertaking, but the residents in the district generally, will be prejudiced by delay; also from the Kensington Court Electric Lighting Company, calling attention to the serious prejudice caused to the company by the delay in dealing with their application for powers to lay underground mains through an extended area in this parish, that it may be notified with the least possible delay, especially as the whole question has still to be reviewed by the Board of Trade.

Gas and Electric Lighting at Glossop.—At a meeting of the General Purposes Committee of the Glossop Town Council, held last week, Mr. Herbert Rhodes replied to a statement made at the last meeting of the Council, during the discussion on the purchase of the gasworks, with reference to the adoption of the electric light at some of the local mills. The firm he represented put 1,400 electric lamps into their mills in 1886; and these gave so much satisfaction that in 1887 they put in another 1,000. Two other local manufacturers had adopted the electric light; and though corporations ought to own gas and water works, he considered that under these circumstances it would be the height of folly to entertain the idea of purchasing the gasworks. The mayor (Alderman Sidebottom) said he quite agreed with these remarks.

The Berlin Telegraph Office.—Friday last will long be remembered, says *The Times*, as the busiest day on record at the central telegraph office of Berlin. The pressure was great on Thursday, when 29,878 telegrams, aggregating 799,926 words, had to be sent off. But this record was eclipsed by the following day, no fewer than 36,615 telegrams, containing together 1,115,551 words, being despatched to all parts of the globe, and in different languages. All the Government telegraphists fit for duty had to be called in to meet the pressure, and all the available instruments were worked. It was a fortunate circumstance that the Berlin Bourse was closed, as this enabled the authorities to make use of the instruments there for the work. During the busiest hours of Friday last no fewer than 346 telegraphists were at work at the same time in the great instrument room of the central telegraph office, and 230 instruments were operated.

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The Snowstorm in America.—On Monday last a snowstorm of unprecedented severity, and lasting until Tuesday noon, or even later, occurred in New York, and extended as far as Boston and Philadelphia, doing immense damage to property, and blocking railway and vehicular traffic almost completely. The fall of snow, which was accompanied by a blizzard, has destroyed a great portion of the telegraph system in the districts we have named, and probably in other places as well, to which all telegraphic communication is for the present interrupted. Overhead wires, both of the telegraphs and the electric light, are lying broken in the streets of New York, buried beneath the snow; and it is already estimated that the Western Union Telegraph Company's system will suffer by this catastrophe to the extent of nearly a million dollars. The breakdown has given rise to one of the most curious telegraphic "dodges" ever recorded. Communication between New York and Boston has been maintained *via* London.

Godalming.—A meeting of the inhabitants of Godalming was held in the Masonic Hall, Godalming, on Tuesday, the 6th inst., to consider the proposal of the Equitable Telephone Association (Limited), of 75, Queen Victoria-street, E.C., to establish a telephone exchange in Godalming and district. The Mayor (Alderman Stedman), in the unavoidable absence of the Vicar (The Hon. and Rev. Canon Brodrick), presided, and after the meeting had been addressed by Mr. A. A. Campbell Swinton and Mr. Macpherson Grant, of the Equitable Telephone Association, the following resolution was moved by Mr. E. Pullman, of Godalming, and on being seconded by Mr. E. Stedman was put to the meeting, and declared by the chairman to be carried *nem. con.*:—"This meeting considers it, in order to keep with the times, desirable to establish a telephone exchange in Godalming if a sufficient number of subscribers can be enlisted." The Swinton telephone instruments were fitted up for the occasion in connection with the hall, so that before they dispersed the visitors had an opportunity of testing them practically.

The Indian Telegraph Department.—*Indian Engineering* says:—"In the resolution published in October last, Government professed a sincere desire to clear the block in the Telegraph Department by facilitating the retirement of the senior officers on special pensions. The profession may have been sincere; but it is already tolerably certain that the Government scheme for clearing the block is not likely to effect its purpose. The resolution laid down that all officers who had eighteen years' service in October last would have the privilege of retiring on special pensions provided they did so before the 1st April next. Unfortunately, many of these officers will have nearly but not quite completed twenty years' service on the date named, so that were they to retire they would, though gaining the special pension, lose the full ordinary pension for which they had nearly qualified. It seems hard that many of the officers in the department should be placed in the dilemma of having to choose between giving up their full twenty years' pension, and losing the special pension granted under the resolution."

Watt's Electrolytic Zinc Process.—This process has lately been submitted to a series of practical trials at the works of the Gülcher Electric Light Company at Battersea, and seems to have proved to be completely successful. An important feature in this process is that while the metal is deposited in a perfectly reguline form, unaccompanied by those crystalline growths of the metal termed "treeing," there is, it is said, literally no evolution of hydrogen at the cathodes, so that polarisation from this cause cannot occur, while there is also no waste of energy from this source. It is stated that the cost of the electrolytic reduction by this process, as compared with the ordinary smelting process, shows a considerable advantage in favour of the former; and while in the process of smelting there is a loss of from 15 to 20 per cent. of metal, by the new process there is practically no appreciable loss. Another significant feature in the Watt process is that ores of low grade can be treated which could not be economically dealt with by the smelter. A company is now being formed to carry out Mr. Watt's zinc process on an extensive scale.

Royal Meteorological Society.—Ninth Annual Exhibition of Instruments.—At the ordinary meeting of the society, to be held by permission of the Council of the Institution of Civil Engineers, at 25, Great George-street, Westminster, on Wednesday, the 21st inst., at 7 p.m., an address will be delivered by the President, Dr. W. Marcet, M.D., F.R.S., "On Atmospheric Electricity," illustrated by experiments; after which Mr. G. J. Symons, F.R.S., will make a short communication "On the Non-existence of Thunderbolts; Elucidated by Accounts of Searches after Them, and the Exhibition of Specimens." The meeting will then be adjourned, in order to afford the Fellows and their friends an opportunity of inspecting the exhibition of apparatus connected with atmospheric electricity, including lightning conductors, photographs of lightning, and damaged objects, and of such new instruments as have been invented and first constructed since the last exhibition. The exhibition will, at the request of the Secretary of the Institution of Civil Engineers, be open in readiness for their meeting on Tuesday evening, the 20th inst., and will remain open till Friday, the 23rd inst.

Obituary.—We regret to record the death of Mr. William Pryor Binney. Mr. Binney was a Nova Scotian by birth, and was the son of the Right Rev. H. Binney, Bishop of Nova Scotia. He commenced his career as a telegraphist in March, 1858, when he went out to the Levant, and has been since that time connected with the Levant submarine cable systems, which were acquired by the Eastern Telegraph Company in June, 1872, and he was then appointed their divisional manager. Mr. Binney died at Syra on Monday night, the 12th inst., and was buried with military honours at that place on the following day. His funeral was attended by the Governor of the Cyclades and the Consular body acting as pall bearers, and also by the civil, military, naval, and ecclesiastical authorities of the island, as well as a numerous *cortége* of sympathising friends, the Burial Service being performed by the Rev. R. Guinet. Mr. Binney was appointed British Consul in the Islands of the Greek Archipelago in September, 1874, which post he held to the day of his lamented death. Mr. Binney had the personal esteem of all the directors and staff at head-quarters, and the company have to regret the loss of a valuable and energetic servant. He was a man of great ability in many directions, rendering conspicuous service in the repairing of cables, in the conduct of negotiations, and as an electrician; in fact, doing well anything to which he chose to turn his hand.

Volunteer Corps of Submarine Miners.—Speaking in the House of Commons on the 9th inst. on the Naval and Military Estimates, Mr. Stanhope said:—"The great mercantile ports of the country were also bound to be remembered. There was a desire in all these ports to raise, for the service of the country, submarine mining corps, which were so urgently required for the protection of those ports. The Government had included provision for raising all the corps in the proposals they now made for carrying out submarine mining, and they had also added whatever sums would be

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required for light armaments for protecting such submarine miners. He knew that was not all that was wanted, but the Government had left it in that way because they wanted to induce the localities to come forward and co-operate with the Government for their own defence (cheers). If they desired to see increased defences, they should come and meet the Government, and tell them what they would do in the way of contribution. He could say for the Government that if the inhabitants of those mercantile ports would do that, the Government would be prepared to meet them, and he was most anxious that no time should be lost in providing for them such defences as were adequate to their needs (cheers). They should do all they could for the defence of these ports as quickly as they could, and he had asked those who were most responsible for advising him in carrying out these defences how quickly they could be completed."

Contract Open for the Lighting of Havre.—The Municipal Council of Havre has issued a circular, of which the following is a translation :—"The Municipality of Havre is prepared to authorise, for a period of six years, an Electric Lighting Company, to establish in the said town a central station, and to lay down in the public streets such conductors, cables, and wires as are necessary to serve the following streets and places :—Rue de Paris, Place Gambetta, Place de l'Hôtel-de-Ville, Rue Thiers (so far as the Rue du Champ de Foire), Rue des Drapiers, Rue Royale. The conduits and cables are to be placed underground, and must be perfectly insulated. They will be subject to the regulations of the Streets Committee. The lighting will comprise, in the districts named above, both private lighting, incandescent lamps, and public lighting, either by arcs or by incandescents. The authorisation will confer no monopoly, and a fixed scale of charges must be agreed on. Under these conditions, the Municipality is prepared to consider communications and propositions from such companies, and would particularly direct their attention to the following points :—(1) At what rate will they be prepared to undertake private lighting? (2) Will they also undertake public lighting? And at what rate? (The tariff should be given both in terms of lamp-hours and by meter.) (3) What annual royalty will they offer to to the municipality? Communications should be addressed to M. A. Rispal, à la Mairie du Havre, before the 31st March."

Liverpool.—The *Liverpool Courier* of Tuesday, March 13th, contains the following :—"In 1883 the Liverpool Electrical Supply Company (Limited) was formed, apparently as a sort of tentative effort to give the electric light a permanent local home. The experiment has succeeded. The original capital was £10,000, but the business expanded and the capital was increased to double that amount, and it will be seen that at the meeting yesterday the directors agreed upon a dividend of 7 per cent. This circumstance suggests that there is not only a demand for the electric light, but that this demand can be met with substantial profit to the shareholders. Under these circumstances, it is not surprising to note that the company have decided to make their business more commensurate with the requirements of the city. To this end they are increasing their capital to £200,000, including the shares to the value of £20,000 already subscribed, and they intend to supply the electric light to all who seek it within a very wide area, comprising the more important residential parts of Liverpool, as well as the great business centres. It is arranged also that the supply shall be by day and night at a regular fixed charge, measured by meter. There has been a supply station in Rose-street for four years, and a second station has recently been started in Tithebarn-street, while a third and more important one is approaching completion in Harrington-street. Besides the use of electricity as an illuminant it is naturally expected that its utility as a motor will become more generally recognised when it is brought within reach of those who need "power" for trade or other purposes. There is one circumstance that must secure for the company's prospectus a careful consideration on the part of the public; the ten-fold enlargement of the undertaking is promoted by responsible Liverpool gentlemen who are fortified by the experience already gained. With a capital of £10,000 the dividends were 5 per cent., while with a doubled capital the dividends have reached 7 per cent., a fact which seems to indicate that proportionately larger profits may be expected from the further extension of the business. The enterprise is of importance to the whole community, and not merely to the investing portion of it, and its development will be watched with considerable interest."

Marking an Era.—An American journal, writing on the New York Electric Club, says :—"The opening of this Club has marked an era. It has marked various other things, but principally an era. You can tell a member of the Electric Club the moment you meet him, for he, like the era, is marked. The doors of the club are so arranged that the moment you press a button the door will fly open. The projectors forgot that somebody might be on the other side of the door, and the consequence is that hardly a member has escaped being knocked down by a suddenly opening door. There is hardly a nose in the club which is not more or less out of repair. The electrical foot warmer has been a success, but the same cannot be said for the boot-blacking arrangement. One of the members got it started and forgot the combination. Before it could be hauled off it had used up a nice pair of shoes, had ruined the stockings and was polishing off his toes when help arrived. Still, taking it all round, the electrical institution has more than fulfilled the anticipations of its projectors. This being the case Detroit capitalists have put their heads and their cash together and have resolved to establish an electric restaurant, which is sure to be a great success. The plans, which we have carefully examined, promise something absolutely unique in the way of restaurants. There will be no waiters, no cashier, no cook, nothing, in fact, that a food consumer usually sees in an eating house, and consequently there will be an entire absence of many aggravating accompaniments to a meal which have been endured simply because it is against the law to slaughter a waiter when he most deserves it. The way it will work is this: A man sits himself down at a table and picks up the bill of fare. The price of every article is marked. He puts a fifty-cent piece in the electrical machine and gets fifty cents back in five-cent bits. Steak, say, is twenty-five cents. He drops five of the coins in the slit beside the steak button, presses the latter and the steak is turned on below. An indicator shows how the cooking advances, the dial being marked from 'very rare' to 'cinder.' At the proper moment he presses the delivery button and the steak comes up through a trap door on the table. In a similar manner the guest calls for potatoes, bread, butter, coffee, and all the rest, taking care to drop the necessary number of nickels into the slits beside the respective buttons. When he finishes his meal he rings as he would at a telephone when he is through talking. Then a man at the central office turns on a current and the dishes disappear, leaving the table ready for the next comer. The Electrical Restaurant Company (Limited) will have a central office with engines, dynamos, &c. They will establish restaurants at various parts of the town, and it is expected that the fact that they will have no waiters will alone given them a handsome profit. Thus electricity has learned to 'labour and to wait,' as the poet puts it."

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ELECTRICAL APPLIANCES USED WITH TORPEDOES AND SUBMARINE MINES.

BY CAPTAIN C. A. M'EVOY.

(Concluded from page 470.)

(Concluded from page 470.)

SPAR OR OUTRIGGER TORPEDO (DUPLEX SYSTEM).

The spar torpedo is employed as an offensive weapon. It is carried at the end of a spar attached to the bow or side of a steam launch, and is fired electrically, either by contact with the vessel attacked, or at will by the operator in the launch. In Fig. 4 is seen a section of the apparatus. In front is carried

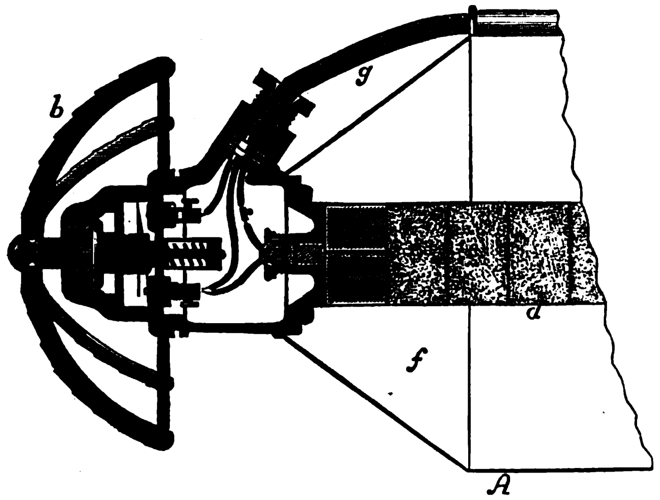

FIG. 4 shows a section of the front interior of the spar torpedo. A. Outer case of torpedo. *b*. Rocking contact maker. *c*. Fuse. *d*. Primary case. *e*. Gun cotton discs. *f*. Space for main charge. *g*. Electric cable.

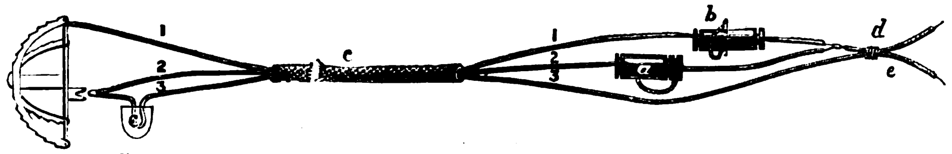

FIG. 5 (diagrammatic) shows the means of firing the spar torpedo and controlling the same from the launch. *a*. Firing key. *b*. Disconnector for controlling the contact firing. *c*. Triple-cored cable. *d* and *e*. Wires leading to battery.

a rocker provided with teeth or notches for making firm contact with the sides of an enemy's vessel. When pressed forcibly either backwards or sideways, the rocker moves inwards and closes an electrical contact, which fires the charge. The torpedo may also be fired at will without the aid of the rocker. The connections by which either of these ends may be accomplished

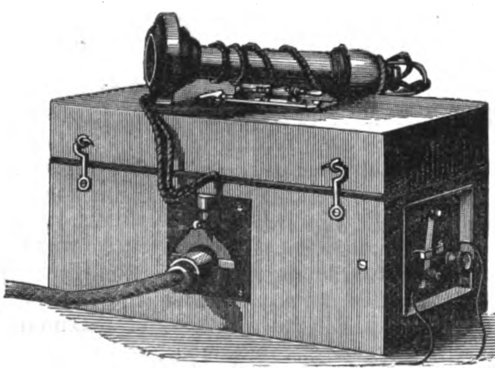

FIG. 6.

are shown in the diagram Fig. 5. *a* and *b* are plug switches; when *b* is closed the fuse can be fired by the rocking contact maker, the circuit being completed through wires 1 and 3; but when *a* is closed the fuse is immediately fired electrically through wires 2 and 3.

SUBMARINE DETECTOR.

This apparatus is employed for finding the positions of torpedoes or mines, lost anchors, chains, &c. It is practically a Hughes induction balance, and consists of a portable box (Fig. 6), having in it a magneto-interrupter, or make-and-break arrangement, and two coils of equal resistance. One of the coils is connected with the terminals of a primary battery, the other coil is in a secondary circuit with a telephone—a length of flexible cable, having four conductors in it, and at one of its

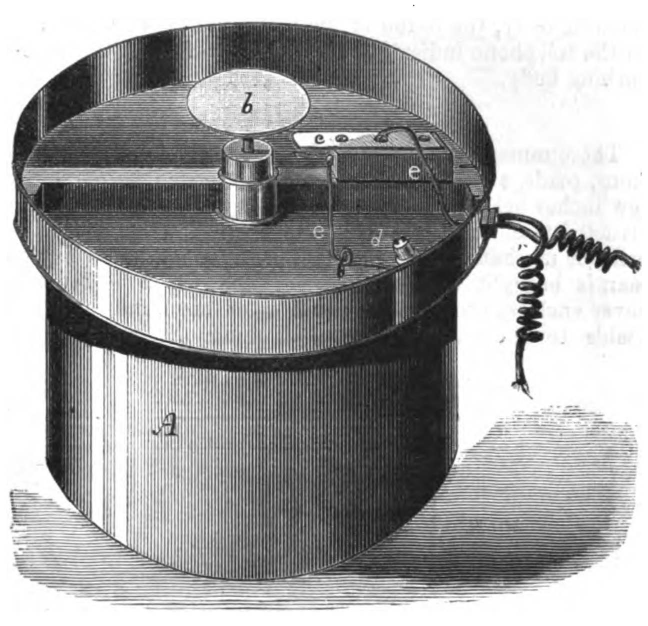

FIG. 9 shows a land mine with its cover removed, and its firing mechanism exposed. A. The body of the mine. *b*. Firing spindle. *cc*. Electric contacts. *d*. Electric fuse. *e*. Insulated wires from battery.

ends a flat box called a sounder (Fig. 7). This sounder contains two coils of the same resistance as those in the portable box, one

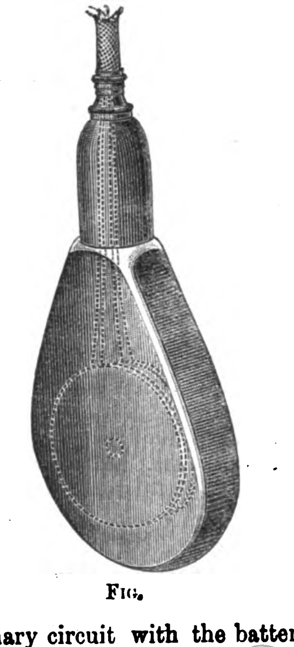

FIG.

being in the primary circuit with the battery, and the other in the secondary circuit with the telephone. The other end

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of the flexible cable is provided with terminal connections for attaching to the portable box. When it is attached and the battery in action, the primary and secondary circuits will be complete through the cable and coils, and the make and break of the interrupter may be heard in the telephone.

An adjustable screw arrangement in the portable box enables the coils to be fixed at the proper distance apart to secure a perfect balance between the coils in the primary and secondary circuits. When the coils are adjusted so that the make and break cannot be heard in the telephone the instrument is ready for use. If the sounder is then brought near a metallic body, the sound of the make and break will be heard in the telephone indicating the presence of a metallic or disturbing body.

LAND MINES.

These mines are employed for the defence of fortified positions, roads, and camps. They are intended to be placed a few inches below the surface of the ground, and are so constructed that they are watertight, and fire themselves electrically or mechanically when the pressure of the weight of a man is brought to bear upon them. A thin metal top or cover encloses the firing mechanism of the mine. This cover yields to the pressure brought upon the mine, and the plunger seen in the illustration (Fig. 9) is depressed, closing an electrical contact, and either giving a signal or else actually firing the mine, the connection being practically the same as already described for submarine mines.

The arrangement for firing the mine mechanically when trodden on is of a novel character. It is desired to cause the pressure, however gradually applied, to deliver a sharp blow upon the detonator. This is accomplished in the following way:—A spiral spring, which is compressed by the descent of the plunger, is fixed at the lower end to a block of metal sliding loosely in an outer tube. This block is held in position in the tube by a thin wire which is threaded through a hole in the side of the tube, and in the block itself. Under the pressure of the plunger the wire first elongates, and then breaks suddenly, allowing the compressed spring to thrust the block sharply down on the detonating cap. Thus the firing of the mine is assured, however gradually the pressure may be applied.

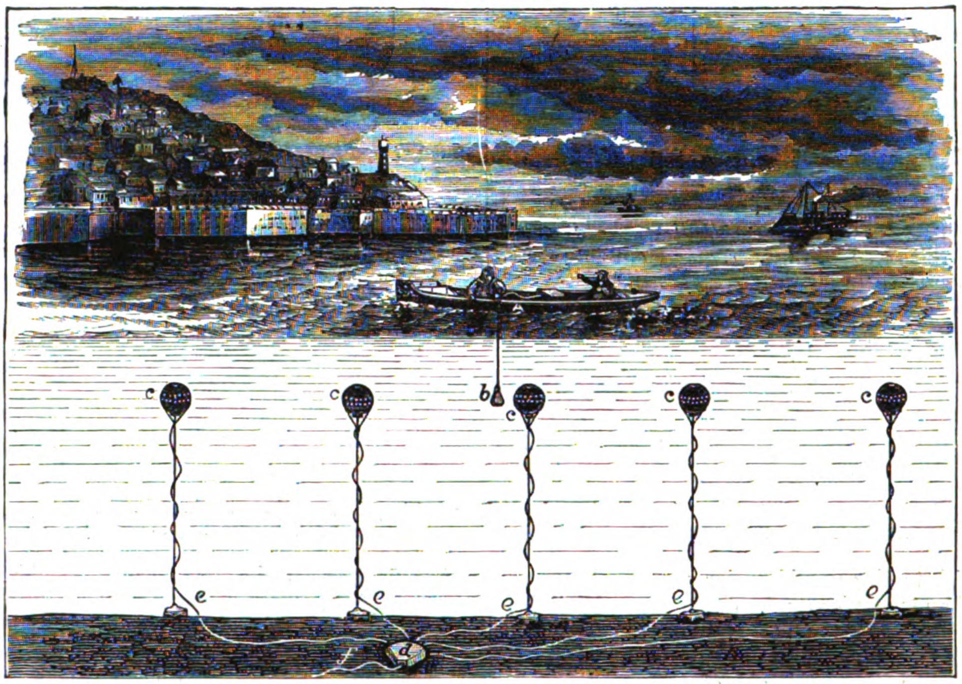

FIG. 8 shows the submarine detector sounder being lowered from an electric launch for the purpose of discovering the presence and position of mines in a harbour. *a*. Electric launch. *b*. Detector sounder, suspended from launch. *ccccc*. Submarine mines. *d*. Junction box. *eeeee*. Single-cored cable connecting junction box with mines. *f*. Main cable to shore.

NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

(Continued from page 406.)

The current equation, expressing the current strength in terms of the impressed electromotive force, the resistance, inductance, and phase angles, which holds good when a circuit of constant inductance and no sensible capacity is subjected to moderately great pulsations of electromotive force, has been in previous pages arrived at algebraically from first principles. It is, however, possible to elucidate its meaning by geometrical methods. Let a circular disc (*see* Fig. 22) be pivoted at the centre O, and at any point P on the circumference let a plummet line be attached. In front of the circle is a fixed horizontal line XX^1. Let the disc move round counter-clockwise at a uniform rate, the time of one revolution being T. As the disc goes round, the length of plummet line PM above XX^1 fluctuates. Since PM = OP sin POM, it follows that if the magnitude of PM be taken at small equal intervals of time during one revolution, and such heights be plotted off as off-sets at equal distances above and below a datum line, the extremities of these ordinates will lie on a simple periodic or sine curve. In other words, PM grows and shrinks in height in accordance with a simple periodic law. We can, therefore, represent any quantity which fluctuates in magnitude according to a simple sine law of growth by representing it as the projection of a point on the circumference of a circle revolving uniformly, taken on a horizontal or vertical fixed line drawn through the centre. Hence, if OP represent the maximum value of an electromotive force fluctuating periodically, PM will represent its various magnitudes during the complete period. The magnitude of PM at any instant is known when we know OP, which is called the *amplitude* or maximum value, and POM the *phase angle* of the motion.

On such a diagram let a radius be drawn to any scale representing by its vertical projection the periodic fluctuation of an impressed electromotive force varying according to a single sine law, and acting on a circuit of given inductance and resistance with a fixed periodicity; the problem is to draw on the same diagram another radius of which the vertical projection shall represent the actual current strength in

the circuit at the corresponding instant. The impressed electromotive force at any instant balances, or is equal to, the sum of two others, viz., the effective electromotive force driving the current, which is equal to the product of the ohmic resistance of the circuit and the current at that instant in it, and the inductive or counter-electromotive force, which is equal to the rate of variation of the flux of force or number of lines of force traversing the circuit. The phases, or times of maximum, of these two components are not identical.

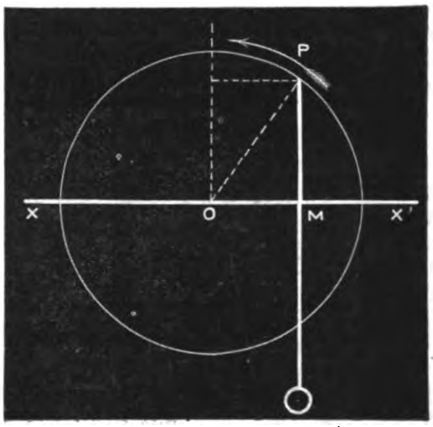

Fig. 22.

They differ by 90°, since the effective electromotive force has the same phase as the actual current, and the inductive electromotive force, depending on the rate of variation of the current, comes to a maximum at the instant when the current is zero or is changing sign.

By the proposition on p. 286, *ante*, these two periodic quantities can therefore be represented by sine curves, one of which is shifted backward relatively to the other, so that the crest of the wave of one coincides with the hollow of the wave of the other. We shall first proceed to show that the sum of two simple periodic motions of the same periodic time, but different phases and amplitudes, will, when added together, produce a simple periodic motion of the same periodic time.

Let a parallelogram of cardboard, O A B C (Fig. 23), be cut out and pivoted by a pin at the angle O, so as to turn freely clockhand-wise. Let a vertical line, O Y, be drawn through O, and in any position let the sides O A, O C, A B be projected

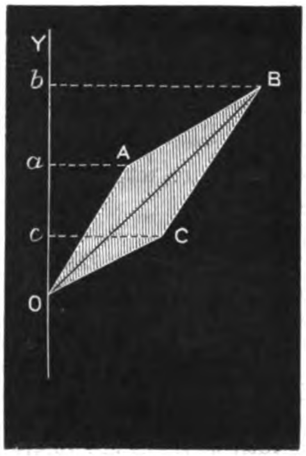

Fig. 23.

on to O Y. The projection of lines equal and equally inclined are equal; hence, since A B is equal and parallel to O C, the projection of A B—viz., ab—is equal to that of O C—viz., O c. But O b = O a + ab always for any position of the card; hence O b = O a + O c. The projection of the diagonal is therefore equal to the sum of the projections of the adjacent sides. As the card moves uniformly round, the magnitudes of the projections fluctuate at each instant, according to a simple periodic law. Hence the sum of the simple periodic motions of which O A, O C are the amplitudes, and which have a fixed difference of phase represented by the angle A O C, is the simple periodic motion represented by O B in amplitude and relative phase. If, then, a point be subjected to two simultaneous simple periodic motions of given amplitudes, and of which the phases differ by 90°, the actual motion will be represented, as to amplitude and phase, by the diagonal of the parallelogram of which these two form the adjacent sides. Returning in thought to electric motion, consider the motion of a *particle of electricity* (if we may be

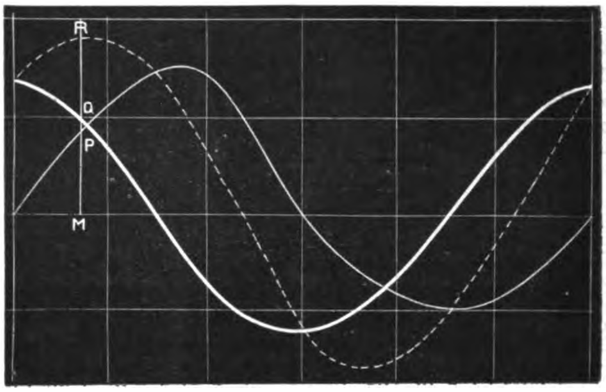

Fig. 24.

allowed the expression) in the wire subjected to two simultaneous simple periodic motions of unequal amplitude and fixed difference of phase equal to 90°. The displacement at any instant due to the two together is equal to the sum of each separately. If the individual motions are represented by the vertical projections of two lines, O A, O B, fixed like hands of a toy clock at right angles (Fig. 24), the resultant motion is that indicated by the projection of the diagonal O C on the same vertical. We have seen (*see* p. 286) that, if the variation of a quantity is represented by a simple sine curve, the variation of its *rate of change* is represented by a sine curve of different amplitude shifted backwards by 90° of phase, or by a quarter of a wave length. It follows from this proposition that if we add together at every instant the motions or the ordinates representing them on a diagram of two simple periodic motions, one of which is the curve representing the rate of change of the ordinate of the other, we shall get a new sine curve, of which the maximum value falls between that of the other two, and of which the amplitude is different, but wave length or periodic time the same. In Fig. 25 the thick white line sine curve represents one wave of a simple periodic motion. The fine white continuous line is a sine curve of equal wave

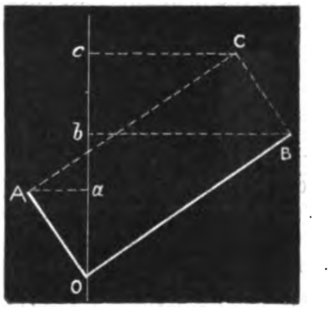

Fig. 25.

length, of which the ordinate P M at any point represents or is proportional to the rate of change of the ordinate Q M of the thick curve at the same instant. Adding together the ordinates of the thick and thin curves, we get a new dotted line sine curve, of which the ordinate R M is equal to Q M + rate of change of Q M. If we substitute for the sine curve diagram a clockhand diagram (*see* Fig. 24), then the projection of O B, viz., O b, corresponds to the ordinate Q M of the black curve; that of O A, viz., O a, corresponds to P M, the

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ordinate of the thin curve; and that of O C the diagonal of the rectangle, O A, O B, corresponds to R M, and is the resultant of the motion O B, and the rate of change of that motion, viz., O A. If, then, O B represents the amplitude or maximum value of the actual periodic current in a circuit, a line, O A, drawn at right angles to O B, will represent to a suitable scale the rate of change of that current.

We are, then, led also to this converse proposition, that we can resolve any simple periodic curve into a pair of component periodic curves of equal periodic time, but of which the maximum value happens for one before, and for one after, that of the original. It is, then, not difficult to see that the geometrical construction necessary is as follows. Let a unit of length be taken to represent a volt, an ohm, an ampere, and a unit of self-induction equal to an earth quadrant or 10^9 centimetres.* Describe a circle whose radius is numerically equal to the maximum value of the impressed electromotive force (*see* Fig. 26). Draw any radius O P to represent the amplitude E of this impressed E.M.F. If, then, the angle P O X is represented by pt, the value of the vertical projection of O P, viz., P M, is $E \sin pt$, and is therefore the instantaneous impressed E.M.F. corresponding to the phase pt. On O P describe a semicircle, and set off O Q, making an angle P O Q with O P, such that the tangent of P O Q is equal to the ratio Lp to R. Where R is the ohmic resistance of the circuit, and Lp is equal to 2π times, the quotient of the inductance of the circuit by the periodic time of the impressed E.M.F., or time of one complete alternation. Join P Q and draw O W parallel to and equal to P Q. If I represents the maximum value of the current, and i its instantaneous value corresponding

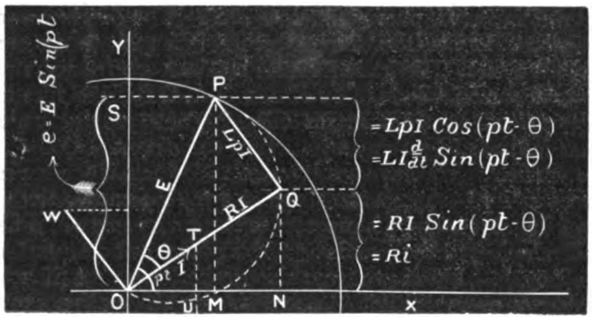

FIG. 26.

to the instant when its phase has certain value $pt - \theta$, we know that $i = I \sin (pt - \theta)$, and the rate of change of the current at that instant is then $\frac{di}{dt} = p I \cos (pt - \theta)$. The ratio of the maximum value of R i to L $\frac{di}{dt}$ is therefore R I to LpI, or R to Lp; but R i is the instantaneous effective electromotive force driving the current, and L $\frac{di}{dt}$ is the corresponding counter electromotive force of self-induction at the same instant, and the sum of these two is the impressed electromotive force at that instant. Consider the two lines O Q and O W, the ratio of their magnitudes is R to Lp by construction, and the sum of their vertical projections is equal to the vertical projection of O P—that is, to the instantaneous impressed electromotive force. Hence these lines O Q and O W satisfy the conditions requisite for being the representation of the maximum effective and inductive electromotive forces respectively on the same scale and relative phase as that on which the line O P represents the maximum impressed electromotive force, and O Q therefore represents in magnitude the value of RI and O W that of Lp I, and the angular positions of these with respect to O P represent the relative phases of the effective, inductive and impressed electromotive forces.

* The unit of self-induction, whose value is an earth quadrant or 10^9 centimetres, has not yet been formally christened. Profs. Ayrton and Perry have called it a *secohm*, and Mr. Oliver Heaviside has proposed, I believe, to call it a *Mac* (after Maxwell). Not to introduce further confusion, we may tentatively adopt the former.

One R^{th} part of O Q is then the magnitude of the maximum current, and its phase of maximum value is behind that of O P by an angle θ. If O T = one R^{th} part of O Q, O T represents the maximum current, and T U, the vertical projection, represents the magnitude of the current in the circuit at the instant when the impressed electromotive force has the value P M.

The respectively varying current and impressed E.M.F. will be graphically represented by the variation of T U and P M as O P and O T move round the circle in equal times, separated from each other by a constant angle of lag P O T = θ. It will be seen that whilst O Q is equal in magnitude to the product of the true or ohmic resistance of the circuit and the maximum current that O W or P Q is equal to the product of Lp and the maximum current. Hence we may call Lp the *inductive resistance* of the circuit, because it is a quantity of like dimensions to the true or ohmic resistance. The angle of lag of the current is therefore an angle of which the tangent is the ratio of the inductive to the ohmic resistance.

If we draw a right angle triangle (Fig. 27), of which the base represents the ohmic resistance of the circuit and the perpendicular the inductive resistance, then the hypotheneuse represents the quality $\sqrt{R^2 + L^2 p^2}$, which has been called the impedance. The angle of lag may therefore be defined thus

$$\text{tangent of angle of lag} = \frac{\text{inductive resistance of circuit}}{\text{ohmic resistance of circuit}},$$

or

$$\text{cosine of angle of lag} = \frac{\text{ohmic resistance of circuit}}{\text{impedance of circuit}}.$$

In order to carry out the construction in Fig. 26 we require to know either $\tan \theta$ or $\cos \theta$. The latter is most easily

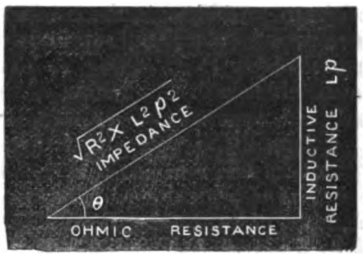

FIG. 27.

determined. The experimental determination of this quantity will be dealt with in due course.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER VIII.—*The Calibration of Current Indicators.*

(Continued from page 478.)

89. *Explanation of Fig. 53.*—The relation between currents and angular deflections up to 28 degrees on the standard horizontal indicator of the General Post Office (illustrated in Fig. 54) is shown by Fig. 53. This is seen to be practically a straight line—that is, the instrument is practically a proportional one up to about 28 degrees. It should be noticed, however, that on closer examination the line is not absolutely straight, although very nearly so, but is tending to bend round slightly. This may be noticed by putting the edge of a flat rule along the line, and seeing how far the direction of the line coincides with the straight edge of the rule, which in this case exactly coincides from 0 to 15 degrees, the remainder of the line up to 28 degrees being very slightly removed in direction from this portion. The readings for this instrument were taken in the same way as the last, except that only one cell was used, the E.M.F. of which was 1·868 volt. It will also be observed that the currents, which are very small, and are measured in millionths of an ampere, or micro-amperes, produce sensibly

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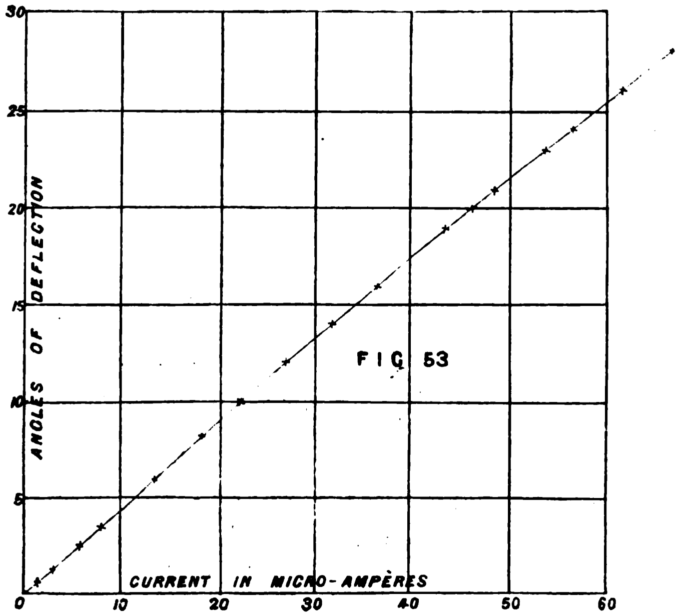
large deflections, which means that the instrument will give perceptible indications when it is circuited with very high resistances and a low E.M.F. For instance, with the single cell used above, it was necessary to insert one megohm (one million ohms) resistance in circuit with the instrument, in order to get the lowest deflection, viz.: about $\frac{7}{10}$ths of a degree. The current producing this deflection would be, in amperes, the

$$\frac{\text{E.M.F.}}{\text{total resistance}} = \frac{1{\cdot}868 \text{ volt}}{1 \text{ megohm} + 800 \text{ ohms}}.$$

We may, however, neglect the resistance of the instrument (800 ohms) when added to so large a resistance as one million ohms, and multiplying the current in amperes by one million to reduce it to micro-amperes, we have

$$\frac{1{\cdot}868}{10^6} \times 10^6 = 1{\cdot}8 \text{ micro-ampere},$$

causing the above perceptible deflection. This shows that the instrument is capable of measuring very large resistances.



90. *Comparison of Instruments by their Figure of Merit.*—Comparing the calibration curves of these instruments will show at once that the same current produces a different deflection on each. This difference is due to the construction of the instrument, the controlling force on the needle, the kind of pivoting or suspension of the needle, and the number of turns of wire on the coils. As a basis of comparison between instruments differing in these respects, we have to determine for each instrument what is termed its *Figure of Merit*, which is simply the total amount of resistance in ohms (including the instrument coil resistance) through which, with one volt E.M.F., a deflection of 1 degree or division is produced. Now, by Ohm's law, this resistance will be equal to

$$\frac{1 \text{ volt}}{\text{current producing 1 degree deflection}},$$

which is the same thing as the *reciprocal of the current in amperes producing 1 degree deflection*, and it is by these words that the figure of merit is usually defined. Hence, an instrument with a high figure of merit is one which will show a perceptible deflection with a very small current.

The figure of merit may be found from the calibration curve by taking any current on the *fi st straight portion* of the curve—that is, the portion of it which is proportional, and observing what deflection this corresponds to; then dividing the current by the number of degrees deflection we have the current for 1 degree, the reciprocal of which, after reducing to amperes, is the figure of merit. Taking Fig. 53 we find by inspection that 12 degrees deflection is produced by 27 micro-amperes; and therefore 1 degree would be produced by $\frac{27}{12}$ $= 2\frac{1}{4}$ micro-amperes, which is equal to $\frac{2\frac{1}{4}}{10^6}$ amperes.

The figure of merit is therefore the reciprocal of this current in amperes, and is

$$\frac{10^6}{2\frac{1}{4}} = 10^6 \times \frac{4}{9}.$$

Now, by inspection of the straight portion of the curve for the astatic instrument in Fig. 52, we find that 18 degrees deflection is produced by 0·1 milliampere, or 100 micro-amperes; and therefore $\frac{100}{18}$ micro-amperes, or $\frac{100}{18 \times 10^6}$ amperes, would give 1 degree deflection. The figure of merit is then the reciprocal of this, which is

$$10^6 \times \frac{18}{100}.$$

If the two instruments are now compared by their figures of merit we have

$$\frac{\text{suspended needle instrument}}{\text{pivoted needle instrument}} = \frac{10^6 \times \frac{18}{100}}{10^6 \times \frac{4}{9}} = \frac{81}{200},$$

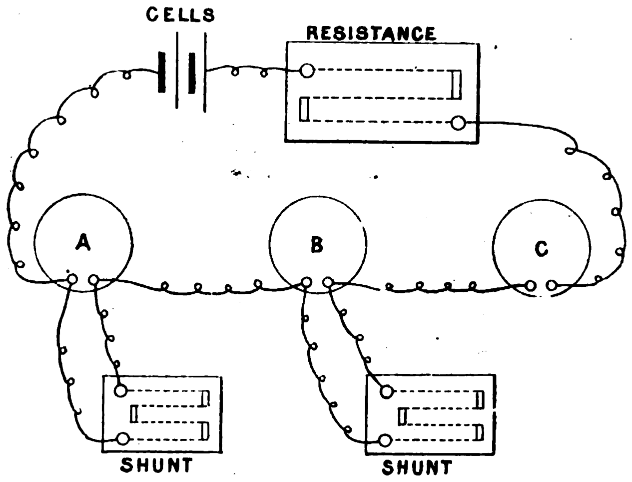


Fig. 54.

that is, the figure of merit of the pivoted needle instrument is $2\frac{1}{2}$ times that of the other, which is the same thing as saying that the astatic instrument requires $2\frac{1}{2}$ times as much current as the pivoted needle instrument for a deflection of 1 degree. If the curve is not determined, the figure of merit may be easily found by passing a weak current through the instrument only sufficient to move the needle a few degrees, say 5; for the reason that mostly all instruments read proportionally to the current for the first few degrees. The figure of merit is then simply *this deflection divided by the number of amperes producing it.*

91. *The Simultaneous Calibration of Instruments of Similar Sensitiveness.*—The calibration of two or three instruments may conveniently be effected at the same time by connecting them together in "series" (para. 40) with a cell or two and an adjustable resistance box (para. 86) in circuit. Whatever current, then, passes through one instrument passes through all, so that, proceeding in the same manner as for one instrument, and supposing, in the first instance, that the instruments are all of the same type, we should expect to obtain somewhere about the same deflection on each for every current passed through. The number of cells would be arranged to give a large deflection on each indicator when no resistance was unplugged in the box, and the successive readings would then be taken by increasing the resistance unplugged, until the deflections became very small.

The current for every change in the resistance in circuit would be, by Ohm's law, the

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$$\frac{\text{E.M.F. of battery}}{\text{total resistance in circuit}},$$

where the total resistance is the sum of the resistances of the coils of the instruments added to that of the cells (if appreciable) and the resistance unplugged in the box. It is advisable for facility in calculating the currents to make every resistance unplugged in the box of such an amount that, added to the resistances permanently in circuit, the total number of ohms for each current becomes a multiple of ten.

The deflections of the needles of each instrument are read off every time a change is made in the current strength, and from these readings curves are plotted for each instrument as previously described.

92. *The Simultaneous Calibration of Instruments differing in Sensitiveness.*—It more frequently occurs, however, in practice that the instruments are dissimilar as regards their sensitiveness. A glance at the curves of the three instruments which have already been considered will show that any given current produces different deflections on each, or, what is the same thing, different currents are required by each instrument to produce a given deflection. For example, taking 25 degrees deflection on each instrument, the curve in Fig. 48 shows that the vertical indicator requires 15 milli-amperes of current for this; the astatic instrument curve (Fig. 52) shows that 120 micro-amperes are required, and the horizontal pivoted needle instrument curve (Fig. 53) shows that about 60 micro-amperes would give this deflection. The latter instrument produces the deflection with the weakest current, and therefore is the most sensitive, the vertical detector being the least sensitive. Now, if three instruments of different degrees of senitiveness were joined together in series and a current sent through sufficient to cause a maximum deflection on the *most* sensitive instrument, the deflections on the less sensitive indicators would be too small to commence with, and therefore by some means the sensitiveness of the instruments must be equalised so as to produce about maximum deflections on each to start with.

(To be continued.)

REVIEWS.

Le Wattmetre et son Maniement. (Ganz and Co., Buda-Pesth.)

This is a little treatise of 17 pages devoted to the consideration of a wattmeter designed and manufactured by the well-known firm of Ganz and Co., of Buda-Pesth. The instrument consists of a movable-coil dynamometer, in which the fine wire coil has very few turns, but is placed in series with a non-inductive resistance. This is the arrangement employed by Dr. Fleming to measure the efficiency of the Zipernowski transformer in the year 1884; it has also been used by Prof. Ayrton, and was spoken of several times during the recent discussion on transformers by the Society of Telegraph-Engineers and Electricians. The instrument is admittedly a convenient one, if only the accuracy of its indications could be relied on. We will return to this point presently.

Judging from the description before us, the instrument, as made by Messrs. Ganz and Co., is all that could be desired as regards mechanical design and finish. The non-inductive resistance is enclosed in a separate box, and suitable plugging and switching arrangements for dealing with high potential difference are provided. Careful instructions are laid down as to the precautions which are necessary to be observed when handling the apparatus under such circumstances, and on these and other matters of detail the pamphlet gives evidence of competent knowledge, and is of a thoroughly practical and useful character.

Returning now to the question of the degree of accuracy of which the apparatus is capable we find that the authors have made an assumption which is not by any means an unnatural one as a first shot, though we are sorry to believe that it will not stand further investigation. They assume that the instrumental coefficient may be expressed by the ratio of the resistance r, of the fine wire branch, to its impedance $\{r^2 + (2\,n\,\pi\,L)^2\}^{\frac{1}{2}}$. In order to show that this ratio is in general closely approximate to unity they give the following numerical illustration as one in which conditions unfavourable to the wattmeter have been chosen:—

Let the resistance $r = 250$ ohms
„ inductance $L = 0{\cdot}02$
Let $2\,n$* $= 200$

Then we shall have $\dfrac{\{r^2 + (2\,n\pi L)^2\}^{\frac{1}{2}}}{r} = \sqrt{\dfrac{62628}{62500}}$, a number differing very little from unity.

It will be noted that the coefficient so obtained is not a constant, because it contains n, the number of alternations per second. This, however, would be a trifling difficulty, supposing the ratio in question to be a true measure of the accuracy of the indications. Unfortunately this does not seem to be the case.

Prof. Ayrton has recently pointed out that not merely is the current through the fine wire coil of a wattmeter diminished on account of the self-induction of this coil, which tends to make the wattmeter reading too low, but that in consequence of the alteration of phase of the current in this coil there is, in addition, another error, which tends to make the wattmeter reading too high, so that, in fact, the actual error is due to the *combination* of these two errors, and he has given the following expression (see *Electrician*, Feb. 24, 1888, page 421) for the coefficient K, by which the readings of the wattmeter of this type must be divided to obtain the true watts:—

$$K = \frac{r}{r'} \times \frac{\tau^2\,r\,r' + \pi^2\,L\,L'}{\tau^2\,r^2 + \pi^2\,L^2};$$

where τ is the time of an alternation $\left(= \frac{1}{2n}\right)$. r is the resistance of the fine wire circuit, and L its coefficient of inductance, while r' and L' are the corresponding terms for the circuit in which the power given is to be measured.

We may write this

$$K = \frac{r^2\,r' + 4\,n^2\,\pi^2\,L\,L'}{r^2\,r' + 4\,n^2\,\pi^2\,L^2},$$

which equals unity only when $L = L'$ or when $L = 0$. It is worth noting also that the instrument may indicate either more or less than the true watts according as $L' > L$ or $L' < L$. From this it appears that the object sought by Messrs. Ganz cannot be attained by merely reducing the inductance of the movable coil to a minimum. If L be small, we may say that approximately

$$K = 1 + \frac{4\,n^2\,\pi^2}{r^2\,r'}\,L\,L',$$

from which it will be seen that K is also greater than unity—that is, the wattmeter always reads too high if L be small. Hence the correction that Messrs. Ganz have taken into account is not only of less importance than the correction arising from the alteration of phase of the current in the fine wire coil, but is actually a correction in the *wrong direction.*

It will be worth while to see how a numerical illustration will work out. Taking the figures supplied in the pamphlet $r = 250$, $L = 0{\cdot}02$, $P = 2\,n = 200$, then we shall have

$$K = \frac{62500\,r' + 7896\,L'}{62500\,r' + 157}.$$

If L' be greater than 0·02, then unless r' be very large compared with L', K will be larger than unity—that is to say, the instrument will read too high. If the wattmeter be used to measure the power given to a transformer we might easily have such values as

$$r' = 5; \qquad L' = 20,$$

in which case

$$K = 1{\cdot}5,$$

or the readings are 50 per cent. too high.

* $2\,n\,\pi$ is now usually written p, and Dr. Fleming proposes to call it a *pulse* or *pulsation* (see *Electrician*, Feb. 24, 1888, p. 404).

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Pott's Mining Register and Directory for the Coal and Ironstone Trades of Great Britain and Ireland. 1888. (London: Simpkin, Marshall and Co.)

This is the first appearance of a volume which it is intended to issue annually and which cannot fail to be of great value to those interested in the important industries with which it is concerned. The contents are well arranged, and its value is enhanced by a series of geological maps reprinted by permission from "Hull's Coal Fields of Great Britain." In the next issue we have no doubt that the editor will find it necessary to insert a section dealing with the electric light in mines, and probably also with electric pumping and haulage. Meanwhile we may add that the printing and get-up of the book are excellent.

NUMBERING CONDUCTORS.

SYSTEM USED BY THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

The denominating numbers of conductors supplied by the Brush Corporation are equal to the number of thousandths of a square inch contained in the section of copper. This denominating number indicates, therefore,

a. How many amperes the wires should carry.
b. How many 65-volt. lamps may be fed by it (approx.).
c. When multiplied by 4, the number of yards to $\frac{1}{10}$ ohm.
d. When multiplied by 4, the weight in lbs. of 1,000ft.

Letters following the denominating numbers indicate the quality of insulation, thus:—

B. Bare.
C. Covered.
D. Drywork insulation.
E. Ship insulation.
F. High tension insulation.

No. 25D is a wire suitable for ordinary house work; it will carry 25 amperes, its weight is $4 \times 25 = 100$lb. per 100ft.; $4 \times 25 = 100$ yards have a resistance of $\frac{1}{10}$ ohm.

On this system—

No. 1 is equal to No. 20 B.W.G.
No. 2 " " 18 "
No. 3 " " 16 "

When it is desired to arrange conductors for any specified fall of potential between the dynamo and lamps, the size of the wire may be obtained by the following formula $N = \frac{LC}{40E}$, that is to say, the required size of conductor is obtained by multiplying the length in yards by the current in amperes, and dividing by 40 times the specified fall in volts.

With the normal current of one ampere per thousandth of a square inch, the fall in volts is equal to $2\frac{1}{2}$ per cent. of the number of yards of conductor in circuit.

(This last is right for copper of $97\frac{1}{2}$ per cent. conductivity.)

(In "*d*" the weight per 1,000ft. comes out 4 per cent. heavy.)

B.W.G. Nos.	Area in inches.	Denominating Numbers.			
		Single.	7 Strand.	19 Strand.	37 Strand.
1	·070686	71	494	1,343	...
2	·0633472	63	443	1,203	...
3	·0526854	53	368	1,001	...
4	·0444881	44	311	845	...
5	·0380133	38	266	722	...
6	·0323655	32	226	615	...
8	·0213825	21	149	406	...
10	·0141026	14	98	268	521
12	·0093313	9	65	177	345
13	·0070822	7	49	134	262
14	·0054106	5	37	103	200
15	·0040715	4	28	77	151
16	·0033183	3	23	63	123
17	·0026421	2·6	18	50	98
18	·0018857	2	13	36	69
20	·00096211	1	7	19	37

MEETINGS OF SCIENTIFIC SOCIETIES.

TO-NIGHT (FRIDAY), March 16th.

SOCIETY OF ARTS.

8 p.m. Indian Section. "The Origin, Progress, and Influence of Universities in India." By F. J. MOUAT, M.D.

ROYAL INSTITUTION.

9 p.m. Discourse on "The Structure, Origin, and Distribution of Coral Reefs and Islands." By Mr. JOHN MURRAY.

SATURDAY, March 17th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Modern Drama: (2) Scandinavian." By Mr. WILLIAM ARCHER.

SOCIETY OF ARTS.

3 p.m. Lecture on "The Protection of Buildings from Lightning" (2). By Prof. OLIVER J. LODGE, D.Sc., F.R.S.

MONDAY, March 19th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture IV., "Alloys" (2). By Prof. W. CHANDLER ROBERTS-AUSTEN, F.R.S.

INVENTORS' INSTITUTE.

8 p.m. Ordinary Meeting.

TUESDAY, March 20th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed, "Economy Trials of a Non-Condensing Steam Engine—Simple, Compound and Triple." By Mr. P. W. WILLANS, M.Inst.C.E.

ROYAL INSTITUTION.

3 p.m. Lecture, "Before and After Darwin" (10). By Mr. G. J. ROMANES, M.A., &c.

SOCIETY OF ARTS.

8 p.m. Applied Art Section, "What Style of Architecture should we follow?" By Mr. WM. SIMPSON. Prof. T. HAYTER-LEWIS will preside.

ROYAL VICTORIA HALL (Waterloo Bridge-road, S.E.).

Lecture, "Food and its Adulterations." By Mr. A. WYNTER BLYTH.

WEDNESDAY, March 21st.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Meeting at the Institution of Civil Engineers. Addresses: on "Atmospheric Electricity," by the President, Dr. W. MARCET, M.D., F.R.S.; and on "The Non-Existence of Thunderbolts," by Mr. G. J. SYMONS, F.R.S. The Society's Ninth Annual Exhibition of Instruments will be opened on Tuesday, the 20th, and will remain open till Friday, the 23rd inst.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Evils of Canal Irrigation in India, and their Prevention." By Mr. T. H. THORNTON, C.S.I., D.C.L. Colonel Sir OWEN T. BURNE, K.C.S.I., C.I.E., will preside.

CITY AND GUILDS OF LONDON INSTITUTE.

Paper (Mechanical Engineering) "Locomotive Boilers." By Mr. F. HOLT.

THURSDAY, March 22nd.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

SOCIETY OF TELEGRAPH-ENGINEERS.

8 p.m. Ordinary General Meeting at the Institution of Civil Engineers. Paper, "On Electrical Stress." By Prof. A. W. RÜCKER, M.A., F.R.S., and Mr. C. V. BOYS.

ROYAL INSTITUTION.

3 p.m. Lecture, "Microscopical Work with Recent Lenses, on the Least and Simplest Forms of Life" (3). By the Rev. W. H. DALLINGER.

FRIDAY, March 23rd.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper, "Principal Types of American Swing Bridges." By Mr. H. W. HODGE, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Lecture by Sir FREDERICK BRAMWELL.

PHYSICAL SOCIETY OF GLASGOW UNIVERSITY.

Paper, "The Scientific Work of Roger Bacon." By Mr. J. STRACHAN, M.A.

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The Electrician.

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NOW READY.

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THE TELEGRAPHS OF THE EMPIRE.

That papers read before the Royal Colonial Institute should be pitched in a high key of patriotic fervour is matter neither for wonderment nor regret. But there are in these days two kinds of patriots—the one who loves his country, respects its institutions, and desires to establish them on the firmest basis; the other who, under the pretence of a superior devotion, vilifies and belittles his countrymen for the purpose of riding any pet hobby of his own which he cannot induce them to mount. Mr. HENNIKER HEATON may not belong to the latter class, but assuredly the paper which he read on Tuesday night answers the description pretty exactly; and it is not our fault if we are compelled to regard him as the exponent of a parochial rather than an imperial sentiment in his treatment of a subject which he claims to have spent the best years of his life in studying. Some of the grosser exaggerations of his paper were exposed in the discussion which followed, notably by Sir JAMES ANDERSON, who had an easy task in demolishing some of the misleading statistics and still more misleading concealments with which the paper abounded. We cannot do more than deal with the general scope of Mr. HEATON'S recommendations and the grounds upon which he asks us to believe that he has based them. Asks us to believe, we say, because, although the grandiloquent language which adorned the address was calculated to impress an audience with the loftiest sense of his object, a calm perusal of his arguments will leave no doubt in any impartial mind that the author speaks as a colonialist, and exclusively in the interests of the particular colony which he represents.

To establish this point we need go no further than direct attention to the magnificent way in which he sets aside all considerations of prudence, of cost to the mother country, and of sacrifice on the part of English capitalists, when advocating a Pacific cable to connect the Australian Colonies with the Canadian land lines at Vancouver. Feasible or not feasible, such an enterprise would be extremely hazardous; confessedly it would require to be heavily subsidised; it would inflict serious injury on the existing lines over the Eastern route, and would in no way help those 240 millions of British subjects in India whom Mr. HEATON treats as Australasian colonists when it happens to square with his argument. But his

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attitude becomes still plainer when we examine Mr. HEATON'S proposals in detail. The Government—the British Government, be it understood—are to buy up the Eastern Extension Cable Company, and become virtual masters of the projected cable in the Pacific. Reasons for this selection are not far to seek under the mist of rhetoric with which Mr. HEATON veils his real object. By this means the Australian Colonies would be relieved of the subsidy they pay to the Eastern Extension Company. This is evidently one object; and, except to gratify a spite—which he does not attempt to conceal—against the Eastern Company, it would appear to be the main object, for no sooner is the Government in possession of the Eastern Extension cables than the Pacific cable is to be laid to compete with it—an arrangement advantageous no doubt for the Colonies of Australasia, but not particularly inviting for the home Government.

Of the strain of lofty benevolence which runs through Mr. HEATON'S paper we have already expressed a profound distrust; but our suspicions are more than confirmed by the frank avowal of his expectations with regard to the effect of his scheme on the future of the company which was the great pioneer of cable enterprise to the East. When speaking of Government purchase Mr. HEATON is in a highly moral vein. "Faith must be kept, and the dictates of honour must be obeyed. If we are to destroy the monopoly which has grown up, let us proceed by just and honourable means." But when it comes to the application of these virtuous monitions, Mr. HEATON is for buying up the Eastern Extension and leaving the Eastern to take care of itself, or, to put it plainly, to bring that company to its knees by the pressure of an overwhelming competition. Sir JAMES ANDERSON, who represented the offending company on Tuesday evening, was apparently in no way alarmed by these ill-considered threats; nor do we see any reason for his being so. We are now more confident than ever, after Mr. HENNIKER HEATON has said his worst, that the British Government will not yield to his enticements. Almost equally certain is it that Australian money will not be found to further the quixotic venture of a Pacific cable; and the more it is discussed the less likely is it to find favour with the English investing public.

In the opening passages of his paper Mr. HEATON eloquently set forth what may be described as the text of his discourse. "Few of us," he says, "who have lived for long years far away from this our loved Fatherland, few who remaining at home ourselves claim kindred with some forlorn wanderer in a distant region, can repress the longing for more frequent communion with absent friends." All this and a great deal more of the same kind to be found in his address may be fine writing, but put to the test of experience we know perfectly well is not sound sense, for it does not represent facts. Absent friends are none the less friendly or comfortable for comparatively infrequent communication such as the postal and telegraph tariffs at present compel. There is nothing to be said against frequent communication, however, except that the parties are not given to it, and would not practise it even if the tariffs were reduced to a popular figure. Similarly, the zeal with which Mr. HEATON binds the whole empire with a girdle of cables for its better security in time of war is discounted by a candid survey of the facts. Either the Pacific cable would be incapable of repairs, or it would be liable to be cut, like all the rest of the cables, directly hostilities broke out. The land lines of the Canadian Pacific Railroad, moreover, are flanked along the whole route by a foreign nation who, if not at war with us, could not be counted upon as friendly. That route is no more secure than any other; and to increase the lines of communication merely for the sake of adding to their number will, if we rely upon them, only increase our embarrassments. Lastly, we note that while Mr. HEATON is, as he alleges, devoting his life to the cheapening of postal and telegraphic communication, he seeks to secure the latter by an appeal to the Government which in respect to the former is guilty of unpardonable illiberality. The inter-colonial post is in the hands of the Government, and Mr. HEATON is continually assailing its extravagance and high charges; but it is in the hands of this administration he would place the cable systems of the world, beginning, of course, with Australia;—and ending there, it seems to us, so far as Mr. HEATON'S real aim and object are concerned, whatever specious professions he may urge to the contrary.

THE LAG IN TRANSFORMERS.

BY W. E. AYRTON AND JOHN PERRY.

As the subject of transformers is now exciting much attention, it may be interesting to mention without now going into the details of the experiments that the investigations of the third year students of electrical engineering at the Central Institution made on a closed magnetic circuit transformer have shown:—

1st. That the lag between the currents in the primary and secondary circuits is practically 90° *in excess* of what it would be if there were no self-induction or magnetic lag—that is, the currents in the two coils are nought simultaneously.

2nd. That the magnitude of the ratio of the coefficient of self-induction of the secondary to its resistance is a sufficient and necessary reason for this extra lag of 90°.

THE TELEGRAPH SYSTEM OF THE BRITISH EMPIRE.

A meeting of the Royal Colonial Institute was held on Tuesday evening in the Whitehall Rooms of the Hotel Métropole, when a paper was read by Mr. J. Henniker Heaton, M.P., on "The Postal and Telegraphic Communication of the Empire." Viscount Bury presided, and among the numerous company present were Sir J. Pope Hennessy (Governor of Mauritius), Sir R. N. Fowler, M.P., Sir J. Corry, M.P., Sir J. Anderson, Sir Terence O'Brien (Governor of Heligoland), Sir Graham Berry, Sir J. Puleston, M.P., Mr. Osborne Morgan, Q.C., M.P., Colonel Duncan, M.P., and Mr. W. H. Lawson, M.P.

The CHAIRMAN, in presenting the lecturer to the meeting, said that he needed no introduction from him, as his industry and knowledge of the subject before them were well known to the fellows of the society.

Mr. HENNIKER HEATON, M.P., who was received with applause, in opening his paper, remarked that, having devoted some of the best years of his life to the prosecution of the task of facilitating and extending the development of human intercourse, it was a rare pleasure to him to be able to expound his theories to an assemblage of whose sympathy he was assured beforehand. With regard to the administration of the postal and telegraphic service within the limits of the United Kingdom, he held that certain improvements were feasible and imperative; but, setting these aside, he thought that it could not be disputed that the vast organisation directed by Mr. Raikes had approached very near to the ideal of what such an institution should be. While, however, the poorest classes in the mother country had facilities for communication, the advantages of written and telegraphic intercourse between the 40,000,000 subjects at home and their 270,000,000 fellow subjects in the colonies were virtually denied to all but the wealthy few. The lecturer proceeded to advocate a scheme for an Imperial penny postage.

Turning to the telegraph service, he said there was another and still higher task to be accomplished—the establishment of cheap and abundant facilities for communication by telegraph.

From a space measurable by yards in the capital of the Empire there radiate lines of communication reaching to Vancouver on the one hand and Wellington on the other.

Trade followed the flag, and the telegraph cable followed trade. At this moment practically the whole of the Empire was in communication with the capital.

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The cables of the world had a total length of 115,000 miles, and cost nearly £40,000,000, the whole of that vast system, with the exception of some 7,000 miles, being in British hands. The majority of the shore stations, too, were on British territory.

The two special points to which he wished to direct attention were the importance of bringing the telegraph into more general use, and the position of the telegraph from a political and strategical point of view.

The telegraph between London, India, South Africa, and the far East, Australia and New Zealand, was a private monopoly vested in the Eastern Telegraph Company, which, like a huge octopus, had fastened its tentacles upon almost every part of the eastern and southern world.

Its own lines ran only to India, but practically it was identical with the Eastern Extension Company, whose lines run to the Australasian Colonies, the Straits Settlements, China and Japan, and with the Eastern and South African Company, with lines running to Zanzibar and the Cape. Sir John Pender was the head centre of this colossal system; he paid a tribute to the marvellous energy and shrewdness by means of which he had created it and fenced it round. It was not only that his companies owned the only line to Australia, but he had made it well nigh impossible for any other line to be laid with advantage to the public.

From the table of charges over the lines referred to it appeared that rates running up to ten, twelve, sixteen, twenty-three, and even twenty-seven shillings per word have to be paid, while the Eastern Company's ordinary shares were now quoted at 15 per cent. premium, the Eastern Extension Company's at 25 per cent. premium, the Indo-European Company's at 25 per cent. premium, and the Great Northern Company's at 40 per cent. premium.

The question came to be, how were we to bring about that reduction of rates which alone can bring the cable into general use, and that immunity from isolation which no single line can afford?

Both objects might be achieved by the one method of constructing an alternative cable *via* Fiji to Vancouver, the Pacific terminus of the new Canadian Pacific Railway, and there connecting with the line through Canada, and across the Atlantic to Valentia.

The Canadian Pacific Railway had been constructed at a cost of £48,000,000, of which about £24,000,000 had been contributed by the Government of Canada in subsidies or without prospect of return. It had brought Vancouver, the uttermost point of Canada, and the chief British naval station in the North Pacific, within a fortnight of Portsmouth. The eastern line of British telegraphs terminated in New Zealand; the western at Vancouver. Connect the two, and at once an electric girdle was put round the world, entirely through British territory. (Applause).

The first section would be from Brisbane or Sydney to North Cape, connecting at the former with the Australian telegraph system, and at the latter with the telegraph system of New Zealand. The length of this section would be 1,300 knots. From North Cape to one of the Fiji Islands, 1,240 knots, would form the second section. The third section would be from Fiji to Fanning Island, 2,270 knots. Then from Fanning Island to one of the Sandwich Islands, probably Hawaii, would be 1,260 knots. From the Sandwich Islands to Barclay Sound or Port San Juan, Vancouver Island, would be 2,730 knots; and from Barclay Sound across Vancouver Island, and the Strait of Georgia, to Vancouver City, the terminus of the Canadian Pacific Railway and telegraph, 100 knots—total, 8,900 geographical miles. The cost was estimated at not less than two millions sterling, and the really practical question is whether the work should be done by a subsidised private company, or should be carried out as a State enterprise by all the Governments interested. An offer had been made to construct this cable for a subsidy of £90,000 a year, but there appeared no doubt that the cheaper course would be for the various Governments to do it themselves. The Governments interested were those of Great Britain, Canada, Hawaii, Fiji, New Zealand, New South Wales, Queensland, Victoria, South Australia, Western Australia, Tasmania, and India, all of which would enjoy the advantages of the alternative route and lower rates of transmission. Now, a private company would want a subsidy of £90,000 a year, and the total capital necessary would be £2,000,000. The Governments would, of course, raise the money at 3 per cent., making an interest charge of £60,000 a year. In reduction of that amount would be the saving made by the Governments in being able to transmit their own messages free; and this amount was estimated at £10,000 a year, so that in reality the burden on the Governments would be only £50,000 a year, or £40,000 less than is asked by the company.

It was pointed out, however—and he quite agreed with it—that the Governments could not properly assist any new corporation to compete with the Eastern companies, who were the pioneers of ocean telegraphy in these parts of the world, and still less could they enter themselves into rivalry with those companies. Faith must be kept. If these monopolies which had grown up were to be destroyed, it must be by just and honourable means.

The logical conclusion was that the Imperial and Colonial Governments should unite to acquire all the existing Imperial telegraphs, and to construct what other lines might be deemed necessary. The existing companies which would be embraced in any such scheme have a total outstanding capital of about 10½ millions. This meant that the cost of the cables must be set down at £300 a knot, or about double the price at which entirely new cables could be laid down now. Moreover, the Eastern companies' cables were most of them not new. The price to be paid for the Eastern Extension lines would be £2,220,000. Then he should propose to construct the new Pacific cable at a cost of £2,000,000, so that a sum of £4,220,000 would suffice to give the independent route *via* Canada, and to compel fair and reasonable concessions from the Eastern Company. The Eastern Extension Company would, of course, have been fully paid out. The interest upon the required capital of £4,200,000 at 3 per cent. would be £126,600; but the purchase of the Eastern Extension Company's business would extinguish subsidies now paid by the Colonies to the amount of £56,700 a year, which would reduce the charge to £69,900. Again, the Hawaiian Government was ready to give £4,000 a year for the establishment of telegraphic communication with America, and this brought the charge down to £65,900. That was the outside total annual cost of the acquisition of complete Governmental control over both the Asiatic and the Canadian telegraphic routes; and he contrasted that sum with the £90,000 annual subsidy demanded by the private company for the construction of the Pacific cable alone. Sir John Pender himself offers to sell these cables at a fairly moderate price (laughter). He maintained that if the Governments acquired the cables they would have from the very beginning a revenue of £300,000, even at the present rates. With reduced rates even Sir John Pender thought that the Imperial telegraphs, taken as a whole, would yield a profit of a million a year. He assumed that the Governments acquired the control of the two routes at the annual charge of £50,000. What follows upon that? No doubt, an immediate reduction of rates. He had expressed the opinion that telegrams could be profitably sent between England and Australia for 1s. a word. The Pacific cable could easily be made to transmit 10 million words a year. That alone would give a revenue of £500,000 a year, sufficient to bear its share of the interest on capital, to pay the working expenses, and to leave a margin of profit. He was only calculating now on the duplicated system of cabling, whereas a new invention has been brought forward by which four messages can be transmitted each way at the same time along a single cable. If they looked away from these islands they saw one slender wire which has to do duty for three, he might say four, continents. They saw foreign Governments lavishing subsidies on packet lines, and carrying foreign merchants' correspondence at half rates to British Colonies and to semi-civilised countries, the trade of which was being insidiously acquired. Worst of all, they knew that every British emigrant was cast off from the mother country as if his patriotism and love of kindred and home had no value. At a moment when envious rivals were looking for a joint in our armour, when dissolving forces were actually at work in the Empire, not an effort was made, not a shilling spent to strengthen and utilise the precious sentiment of brotherhood which nature had planted in the great Anglo-Saxon race (loud applause).

DISCUSSION.

Colonel DUNCAN, M.P., then addressed the meeting, confining his remarks chiefly to the postal service.

Mr. OSBORNE MORGAN, M.P., said he believed that the true solution of the problem was to put the telegraph service, like the postal service, in the hands of the Government; but how to do it was a matter of detail. His hon. friend had converted him from being an opponent into an ardent and sincere supporter of his postal proposition.

Sir R. N. FOWLER, M.P., said he had, in common with his friends who had preceded him, to congratulate his hon. friend upon the very interesting paper to which they had listened with so much pleasure.

Sir JOHN POPE HENNESSY, after referring to the postal question, said: Might he be also allowed to say a single syllable upon that burning question upon which they were soon to hear from Sir James Anderson? He did not at all agree with Mr. Henniker Heaton in some of the remarks he made about the Eastern Telegraph Company, for he could not admit, though it was spoken of as a great monopoly, that it was in any shape or form doing any injury to the Empire; on the contrary, speaking as an official who had been in various Colonies, where he had met with the Eastern Telegraph Company, he was bound to say he knew no company which had done more to bind the Empire together than the Eastern Telegraph Company; and as an illustration of what the Eastern Telegraph Company was endeavouring to do he would mention the case of the Colony with which he had the honour to be connected. Sir Henry Barkly was well aware of the importance of telegraphic communication with Mauritius, because he, too, was a Governor in that Colony, and he knew that the Island of Mauritius was without telegraphic communication. It was called by naval and military men the Key of India, and it was also of great importance for the defence of Australia. And yet they had no telegraphic communication with Mauritius. He received an offer from the Eastern Telegraph Company not many years ago. They undertook to establish telegraphic communication, to

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run a wire from Africa to Mauritius, and to work that cable for the sum of £20,000 a year. Anyone who knew the responsibility attached to laying down a telegraphic cable and keeping it in repair would understand that that was a most generous offer for the Eastern Telegraph Company to make. He was able to induce the Local Government of Mauritius, the House of Assembly, to vote one-half of that money, £10,000 a year, on the condition that the Imperial Government here would give the other £10,000, which it was thought it should do, having regard to the Imperial interests at stake. He was sorry, however, to say that up to this time he had not been able to induce the Chancellor of the Exchequer in England to give £10,000 a year; but lately he had gone again to the Eastern Telegraph Company, and he found now that they were willing to re-open the question, and he believed for the comparatively small sum that it was proposed to raise in Mauritius they would give the island that cable. He thought the chairman had every reason to congratulate himself upon presiding over a meeting in which a paper of this kind had been read. Many members of Parliament were present under circumstances of which they could understand the difficulty, and he thought it was a subject of congratulation to all members of that Institute that they had been permitted to take a part in the proceedings of the evening.

Sir JAMES ANDERSON thought he might be pardoned if he appeared on this occasion as something of a critic of this paper. So many nice things had been said that a few minutes ago he was frightened; but he had more confidence since the last honourable speaker had said that, after all, the Eastern Telegraph Company, which he represented, was not so bad as the paper made it look. The feeling he had in reading this paper was that it was ornamented with a great deal of inflated language (laughter)—he must be pardoned for saying so—though the honourable members of Parliament who spoke had said things so nice that there seemed to be nothing but niceness about it. The paper opened with the astounding statement that there were 270,000,000 of our Colonial fellow subjects suffering owing to dear postage and dear telegraphic communication.

Mr. HENNIKER HEATON: Nothing of the kind.

Sir JAMES ANDERSON: You say so, pardon me, in the third or fourth line.

Mr. HENNIKER HEATON: No, sir.

Sir JAMES ANDERSON maintained that Mr. Henniker Heaton had stated that 270,000,000 of their Colonial fellow subjects were suffering under the pressure of dear postage and dear telegraphy. In the paper it was also stated that, thanks to the trade with the Colonies (and for this purpose Mr. Henniker Heaton made India a Colony), we were enabled to maintain 500 war ships and 500 clipper steamers for war purposes. Then from that time British India dropped out, and nothing more was heard of it excepting in this way, that for anything done in the way of cheapening telegraphy or postage, the Board of Trade or the Admiralty, or somebody in the mother country, ought to bear the expense. Then, again, it was said that this country and the Colonies were so much indebted to the great steamship companies for having developed Colonial enterprise and Colonial progress that we owed them a debt of gratitude which we could never repay. A few lines further down Mr. Heaton said that he took £100,000 from them. That was one way of paying a debt of gratitude. Mr. Heaton said, again, that he would reduce it more; then that the enormous subsidies must be substantially reduced and taken away altogether. That was his mode of paying the debt of gratitude which could never be repaid. He thought it would be as well to begin at once, and not pay anything. With regard to the Post Office and the Telegraphs Mr. Heaton said that upon them depended the supremacy of their commerce and the stability of the Empire; then there were hundreds of thousands of poor emigrants who could not pay the postage of a letter, but for all that they sent more than £300,000 to their poor relatives in the mother country last year, and in that way he rang the changes; and it was in that way that he meant that Mr. Henniker Heaton had indulged in what he called "too beauteous" language. With regard to Mr. Heaton personally, Sir James remarked that they were old friends and had worked together. Mr. Heaton spoke of the telegraphs as a huge octopus, and of the Eastern Telegraph Company as a terrible and unendurable monopoly. In considering the company as a monopoly, he would ask them to look at the map. All the land in the world east and south of the meridian of Greenwich, excepting America, is there; all the ports of the old world; all the millions of the inhabitants with whom we have been trading all through our history, for British products were sent eastward even in prehistoric times; all the millions of inhabitants with whom we yet hope to establish and develop traffic exist in these great continents, and along that eastern line are the ports of the world where our ships can take shelter in time of war, and our cruisers find supplies. £200,000,000 of our annual foreign trade is there, and 15,000,000 tons of our shipping is employed in that trade, and the British trader had gone there to buy and sell his goods and to bring home the products. It would have been strange if the company had not gone to the places where commerce existed, and where were all the ports of the world. It went without saying that the company laid its cables where the commerce was. The octopus spread out its tentacles to all those ports. Now let them listen to this. The company had no privileges. The company laid that cable all the way to India, Australia, and China, and never got a farthing of subsidy or a bit of encouragement. They laid cables to Spain, to Portugal, to France, Austria, Italy, Greece, Turkey, Russia, Asia Minor, and Egypt, and this so-called monopoly was competing with the Government of every one of these countries at the same tariff. The cables were laid by permission to the ports of these countries, and the company was allowed to have English hands to work them, and the company took its chance of picking up unconsidered trifles which they did not seem to appreciate, and so they paid the enormous sum, as Mr. Henniker Heaton called it, of five per cent., sometimes 5½ per cent. dividend, and that was what had been done by private enterprise. Mr. Heaton said that the company followed the trade and followed the flag. The company followed the flag to Besika Bay, to Gallipoli, to Constantinople, laying a cable within a pistol shot of the Admiral's ship. They went to Port Said and followed Sir Garnet Wolseley to the point of departure for Tel-el-Kebir. That was off the company's "own bat," and no money was paid them for doing it. They laid cables also to Suakim, and the organisation which had effected this result of British enterprise Mr. Heaton spoke of as a gigantic octopus and a private monopoly, and in this respect he thought Mr. Heaton had used undue language and had not been so fair as he ought to have been. With regard to tariff, Mr. Heaton knew very well that the company came down to quarter rates for the press, and not only that, but allowed messages to be "skeletonised," which meant that every word was developed into seven or eight; yet this was the "monopoly" which was held up to censure and scorn by Mr. Heaton. Mr. Heaton thanked him over and over again, and said he thought they were liberal, and that he would be the friend of the company; yet now, for some reason of personal pique, he came forward and read a paper against them as being a gigantic monopoly. With regard to what Mr. Heaton said about the Government control, he (Sir James) claimed to have been the first to put that into his head. At Berlin he proposed the substance of a plan with which Mr. Heaton was very much pleased, and if that plan were adopted the Government might take over the telegraphs, paying 4 per cent. on the present capital, and keeping up the present tariff they would have a quarter of a million to do what they liked with. They could reduce the tariff one half and still make a profit. Private companies could not do that. Sir John Pender had put before the Colonial Conference still another plan. The directors were the trustees of their shareholders, who had a right to demand some interest for their money. They must walk steadily and warily, as they best could. He would take the case of the American cable companies. Four of the cables belonged to Americans and one to the French, and they were not going to give up their cables to the English Government, neither were foreign Governments going to allow the English Government to land, and acquire stations upon their territory, and put English subjects to work the cables. It was all very well for foreign Governments to give such rights to a private company, because they could turn them out, and could always control them, but that was a very different thing to giving the English Government landing rights and stations, and a position upon foreign territory; and if the two ends were to be under different direction and control, with operators of different nationalities, there would be no telegraph at all worthy of the name. Hence he did not think there was any probability, nor did he think there was any great desire, that matters should be otherwise than they were. At the same time, if the Government desired a cheap telegraph, he had shown how they could have it. His own company had not the least desire to keep the monopoly, as it was called. The Government would have to pay the shareholders for it, and not too much either. The company, he contended, had shown as much British pluck and enterprise as their forefathers ever did (applause). He had one word to say about the proposed cables. He did not see any poetry or romance at all, or anything worth talking about, in laying a cable round the globe from east to west any more than from north to south. He did not see the use of it. There was nobody there to telegraph. There was talk of taking a cable all the way from Australia to the Mauritius, across the route of the trade winds to the Cape. There was not even a sandbank on which to catch fish; there was not a port to which a cruiser or a cable ship could go to replenish their supply of coal, which they were certain to require to do. There were no ships going there; there was no trade, and nobody wanted to go there. Take the cable from Canada down to Fiji and New Caledonia, which was a French convict settlement. Well, what was there? Mr. Heaton, in his paper, dropped India and China, he dropped the Cape, and he dropped everything but Australia, where the whole of his mind was centred, and naturally so, he should suppose (laughter). He wanted a cable from Australia, where there were four millions of people, to go round the Cape or across the Pacific. He (Sir James) did not believe in it a bit, and he hoped that no one with whom he had influence would ever put a penny of money into it, but leave it to those gentlemen who did not know any better. They did not know what was involved in laying long cables in vast oceans. They would all want repairs in time, and they must have large ships with great coal endurance to go out for that purpose, because there was no place where their coal supplies could be replenished. These cables were, of course, to compete for all the trade, and to take it away from this poor company. Another word about the "monopoly." The competing companies (Indo-European and Eastern), neither of whom could at one time make a living, naturally combined and formed a working agreement, as anyone would combine if they found it to their advantage, in a free country. Well, that was the head and front of their offence, and to have held the companies up for doing so was something that Mr. Henniker-Heaton should regret. At any rate, he did not think it was fair. Does he believe that the Governments of Russia, of Germany, of Austria, of France, &c., would agree to the Government of Great Britain having all the cables in their own hands? Of course they would not. They would not let them take the Indo-European line or the Russian overland wire. Again and again he was told when he was in St. Petersburg some years ago by the Russian Postmaster-General that, no matter whether it paid or not, no matter what they lost by it, they would maintain that line for political purposes. He had just one other word to say about war. The idea that the submarine cables could or should be relied upon in time of war was nonsense. He had taken every opportunity of saying so. The Colony, or the merchant, or Government, or admiral, or commander-in-chief who did not arrange his plans so as to know what he would do when the cables were cut on war breaking out, was not fit to be at the head of the concern. All that they could do in time of war was to take the best care they could,

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when the cables were cut, to repair them as soon as possible. These "monopoly" companies had at present 2,000 miles of cables in tanks in nine parts of the world. They had eight cable steamers ready at this moment to effect repairs, and if they saw a glimpse of war clouds they could double both ships and cables. And that was the policy every one would have to adopt. The commander-in-chief of the army, the admiral of the navy, would have to see his plans arranged so as to hold his own somehow or another, as he best could, till he could get into communication with headquarters if he required reinforcement. There was no other way of dealing with the question of cables in time of war (applause).

The CHAIRMAN said it was not his duty to decide which among the various opinions which had been expressed was the right opinion, but to sum up, in a very few words, the result of the debate, and to conclude by proposing a hearty vote of thanks to the lecturer. It seemed to him that both sides were a little carried away. Mr. Henniker Heaton was, fortunately for the world, an enthusiast. It was well that there should be men who, pushing all obstacles aside, should fix their eyes on some great idea to be realised. He thought the suggestion of Mr. Henniker Heaton, that the Government should take over the cables, was contradictory. He was evidently not satisfied with the Government. He thought that where a Government made a profit upon one part of their business, that profit ought to be expended in diminishing the expense of another part. He did not seem to think about the Government doing their duty well. As to the Telegraph Department, he was afraid that the feelings of his dear old friend, Sir James Anderson, had been very much ruffled by his company being referred to as an octopus. He thought it was greatly to the credit of that company, under Sir James's auspices, that it should have spread its feelers all over the world. Mr. Henniker Heaton thought that the work could be done by the Government with satisfaction to the telegraph companies and with less burden on the community. Well, he thought there was something in that argument. The Chairman proceeded to give an instance that occurred in connection with an important company, of which he was chairman, in which he wished for a return from the Cape of Good Hope of some commercial transaction in which the company had been engaged. He directed the secretary to ask by letter for a return by telegraph of certain sums which had been paid in that country. A cipher telegram came back without the slightest delay, but the result was not particularly intelligible, or exactly what they wanted. The company was very anxious to have full information, and he directed the secretary to telegraph back and have the telegram repeated in plain figures. Then it came to be a question of cost, and he decided not to go to so high a figure as from £15 to £20. The cable was probably vacant for several hours during the day on which that event happened, and the Company might have repeated the message, in his opinion, for about 5s. a word, or much less, perhaps, without losing anything. As it was they did not get his £30, but if it had been a question of £10 instead of £30, they would have got it. That, he took it, was a specimen of transactions which probably often occurred, and which would result to the advantage of the Company if the tariff had been smaller. Mr. Henniker Heaton did not blame the companies because they made the best living they could for themselves. He only hoped that it would become patent to the world that lower rates, whether by post or by telegraph, would be an advantage. It was not a question of finding fault at all one way or the other, but as Sir John Pope Hennessy said, it was a grave question of finance, and finance only. It would eventually be seen that just as the penny post enormously increased the amount of correspondence, and therefore enormously increased the revenue of the Post Office, so lower telegraph rates and lower postal rates would eventually redound to the advantage of the sender and carrier. He believed that to be, in one word, the point at issue. He concluded by proposing a vote of thanks to Mr. Henniker Heaton for his lecture, which was carried by acclamation.

Mr. HENNIKER HEATON, in reply, said he thought it was a matter for congratulation that they should have had four gentlemen speaking who might be regarded as representatives of the four great objects of attack. With regard to Mr. Pearson Hill, that gentleman asked him to do his best to get the Australian Colonies to join the postal union. The postal union was the greatest humbug they had. From England to British India the postal charge was 5d., whereas it was only 2½d. from France. The idea of joining a postal union in which such an anomaly as that existed! When he asked the Postmaster-General whether he would reduce the rate to 2½d., he said, "No, I cannot reduce it under 5d." That was what would be gained by the postal union. He hoped that within the next 48 hours a reduction of 50 per cent. in the rate to Australia, namely, from 6d. to 3d., would be announced. It was only a little time ago that he heard Mr. Pearson Hill read a paper before the London Chamber of Commerce on the reduction of postage to 2½d. It appeared, therefore, that Mr. Hill was in favour of a reduction, though he did not go so far as he did. He did not think that a reduction to 2½d. would have been obtained if a reduction to 1d. had not been asked for. Sir James Anderson rather gave them to understand that not a farthing of subsidy was received by the Eastern Telegraph Company from anybody, and that they had no privileges at all.

Sir JAMES ANDERSON: We laid our cables to India and China, and up to that time we got nothing. Afterwards Australia wanted cables, and we got a subsidy.

Mr. HENNIKER HEATON stated that it was a fact that Sir James Anderson received a subsidy of £32,000 a year from the Australian Government. That was a terrible thing for any rival company to deal with. What could they do under any circumstances but buy this octopus out (laughter)? The Eastern Extension Company, of which Sir John Pender was chairman, got £60,000 a year for the South African cable. He opposed it in the House of Commons, but he was not quite strong enough for these gentlemen. Mr. Henniker Heaton concluded by proposing a vote of thanks to the chairman.

THE ELECTRIC LIGHT IN ROME.

The Electric light has lately made rapid progress in Rome. We have already chronicled the establishment of a central station by the gas company, from which distribution is effected by means of transformers on the Zipernowski system. The Municipal Council has recently authorised the erection of nine arc lamps upon the Piazza della Quirinal. These lamps take a current of 16 amperes, and are placed upon posts 22ft. high. The lamps are of 1,000 candle-power nominal, and are enclosed in opaline globes. The posts are of very ornamental design, and the effect of the whole is very pleasing. The current is supplied by transformers, which are placed at one of the corners of the Municipal Buildings in a small chamber built into the wall. A special underground conductor has been laid down as far as the corner of the Via Nationale. This underground line is working extremely well at present. The cables were supplied by Siemens, of Berlin, and in point of economy compare favourably with the Berthoud-Borel type, which is chiefly used by the Gas Company. The Quirinal Theatre possesses an installation of 200 incandescent lamps. The lamps upon the stage are regulated by means of a set of impedance coils, a feature to which the transformer system readily lends itself. The Theatre Metastasio is lit in the same manner, but in this case arc lights are used for the stage lighting. Several powerful projectors are employed, which are regulated by hand. In both cases the lighting is of a highly successful character. The extensive retail establishment of Bocconi Frates has also been lit throughout. It comprises 86 arc lamps of 2,000 candles, and 200 incandescents of 16 candle-power. The incandescent lamps are supplied by an Edison dynamo driven by an Otto gas engine of 12-horse power nominal. The arc lamps are divided into ten separate circuits, each supplied from a separate transformer placed in the cellar of the establishment. The current is charged for per lamp-hour, and not by meter. Another installation worthy of mention is to be found upon the premises of Finzi and Beanchelli. Five arc lamps of 500 candle-power are hung outside the windows of the shop, and the interior is lit by nine lamps of the same size. These lamps take a current of eight amperes. The total motive power available in the central station amounts at present to 1,500 horse-power. The whole of the installations referred to have been carried out within the last few months.

MAGNESIUM AS A POSITIVE ELEMENT.

Owing to the high price of magnesium it has not hitherto been worth while to consider its use in the primary battery as a substitute for zinc. The metal has, however, lately been falling in value, owing to the introduction of the electrolytic process in its manufacture, and is now worth about 9s. per pound. Although this price is still prohibitive for ordinary purposes, yet M. Hein, in view of the possibilities of a further reduction, has made a careful study of the E.M.F.'s obtainable with magnesium cells, and has published the results in a recent number of the *Elektrotechnische Zeitschrift*. From this paper we compile the following tables :—

DANIELL CELL TYPE.

Positive element.	Solution.	Negative element.	Solution.	E.M.F. in volts.
Magnesium	Dilute sulphuric acid	Zinc	Dilute sulphuric acid	0·876
Magnesium	Dilute sulphuric acid	Copper	Sulphate of copper	2·03
Magnesium	Sulphate of magnesium	Copper	Sulphate of copper	1·93

The substitution of magnesium for zinc in an ordinary Daniell cell therefore increases the E.M.F. by about 0·85 volt.

BUNSEN CELL TYPE.

Magnesium	Dilute sulphuric acid	Carbon	Dilute nitric acid	2·888
Magnesium	Sulphate of magnesium	Carbon	Dilute nitric acid	2·863
Magnesium	Chloride of magnesium	Carbon	Dilute nitric acid	2·910

The substitution of magnesium for zinc in a Bunsen cell therefore increases the E.M.F. by about 0·89 volt. Using a specially hard "electric light carbon," an E.M.F. as high as 3·023 volts was obtained.

BICHROMATE CELL TYPE.

Magnesium	Bichromate solution	Carbon	Bichromate solution	2·952
Magnesium	Dilute sulphuric acid	Carbon	Bichromate solution	2·980
Magnesium	Sulphate of magnesium	Carbon	Bichromate solution	2·901
Magnesium	Chloride of magnesium	Carbon	Bichromate solution	2·970
Magnesium	Chloride of magnesium	Carbon	Specially concentrated solution.	3·046

The substitution of magnesium for zinc in bichromate cells increases the E.M.F. by nearly 1 volt.

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LECLANCHÉ CELL TYPE.

Magnesium	Chloride of ammonia	Carbon & dioxide of manganese.	Chloride of ammonia	2·219
Magnesium	Chloride of magnesium	Carbon & dioxide of manganese.	Chloride of ammonia	2·334

The substitution of magnesium for zinc in Leclanché cells therefore increases the E.M.F. by about 0·63 volt.

Unfortunately, it appears that it is difficult to prevent a considerable amount of local action in these cells, and it should, moreover, be noted that the magnesium salts in solution have a specific resistance from 30 to 50 per cent. higher than that of the corresponding zinc salts. M. Hein is, however, of opinion that when a small current of high E.M.F. is required the Leclanché type will prove useful, and even, in some cases, economical. For instance, for medical purposes he considers this cell to be decidedly preferable to the bichromate type, in which, in order to obtain a constant E.M.F., the frequent renewal of the solution is necessary. The Leclanché type has, of course, the further advantage that it does not require the use of acid solutions.

CENTRAL STATION LIGHTING.

INDEPENDENT ENGINES IN INDEPENDENT STATIONS.*

BY WILLIAM LEE CHURCH.

The service of electric lighting differs from other forms of manufacture in requiring more horse-power per square foot of floor space; in requiring higher speeds; in demanding the power in larger units; in compelling a closer and more uniform regulation; and in requiring more rapid and constant extensions. It will be observed that these peculiarities require individual and special treatment in the generation and distribution of power, and engineering practice as determined in other means of manufacture may be sadly at fault when applied to electric lighting.

It has become an axiom among experienced station managers that the money is made or lost between the shovel and the belt; in other words, other things being equal, the dividend-earning capacity of a station is determined by its steam plant, to which the electric apparatus is in the nature of an accessory.

Incandescent lighting has not until recently made a brilliant record as an investment, and much of the disappointment is directly traceable to the culpable ignorance of the principles of steam engineering which has been displayed. A man who will not venture to cut himself a $2.00 vest will not hesitate to exercise his amateur talents upon a steam plant, upon the economical and reliable performance of which depends an investment of one hundred thousand dollars and the public service of a city. A long and critical experience in this branch of industry has grounded us in the conviction that no incandescent station can hope to be financially successful, under the ordinary conditions of competition, unless based on independent dynamos belted direct from independent engines. Throughout this paper, therefore, we desire to keep constantly in view the opposite systems—namely, a station containing a given number of dynamos of two or three different capacities, each belted direct from high-speed engines of corresponding rating, and, on the other hand, the same station with the dynamos driven from one or two slow-speed engines transmitting their power through one hundred feet of shafting, more or less, encumbered with clutch pulleys. Having these pictures well in mind, we inquire:

What are the essential requirements of a first-class steam plant in an incandescent electric light station? Taking them up in the order of their importance, we unhesitatingly say first, and always foremost, *absolute reliability for continuous running.*

The electric light company contracts to supply the demand of a diverse and exacting public, and that public expects to find its light on tap at every moment of every hour of every day in the year. Failure of service in ever so small a degree is palliated by no excuse. Complete reliability is the condition of popularity, confidence and patronage, without which all the other economies and excellencies go for nothing.

Again, electric lighting perhaps more than any other industry has its earnings directly affected by the shutting down of its power, since it sustains a direct financial loss for lights out, aside from custom and reputation, not easily regained. Subdivided power reduces this risk to a minimum, and, properly directed and applied, obviates it altogether. In a station using, say, 2,000 horse-power, say in the shape of two large engines, loss in lamps in one night by the shutting-down of one of these engines is equal to one-half the cost of an independent engine on the subdivided plan; in other words, as tersely expressed by a manager of experience, a company might better, for peace of mind, reputation, and cash balance on the books, throw a 60 horse-power engine into the scrap pile than to shut down the station one hour. The service of electric lighting is similar to the editing of a daily paper, in that lost time can never be regained. Most industries can make up lost time by working overtime, and pushing their business in various ways, but in electric lighting—

"The mill will never grind with the water that has passed."

Passing from argument to instance, we cite the recent experience of one of the largest stations in the country, operating in the neighbourhood of 20,000 lights. This station, as originally planned, was driven from a pair of Corliss engines, each having a cylinder 28in. in diameter by 48in. stroke, and belting to a countershaft 4½in. in diameter by about 50ft. in length. From this countershaft are driven five dynamos, having an aggregate capacity of six thousand 16 candle-power lamps. Clutch pulleys 8ft. in diameter, which are the means of disconnecting the dynamos when not in use, with similar clutch pulleys for exciters. The remaining dynamos in the station are each of 2,500 lights capacity, and each driven by a 200 horse-power independent engine, belted direct. Recently, in the middle of the heavy run of the evening, one of the clutch pulleys broke in some of its parts, necessitating the immediate shutting down of the 6,000 lights, besides doing considerable damage and involving danger to the *employés*. The extinguishing of such a large number of lights at the important hour of the run was a blow at electric lighting of the severest nature, and working serious inconvenience to public gatherings. It happened that one of the independent engines, with its dynamo, was immediately available, and was started within two or three minutes, so as to take up a portion of the load of the large engine. In this same station, at a subsequent time, a key became loose on the valve gear of the engine, necessitating another stop for several minutes. On still a third occasion the crankpin became uncomfortably hot, and was carried through the run only at a great risk and labour. This illustration is used as one among many of the almost evident fact that no electric light station can afford to hang its whole business upon any one source of motive power, particularly when that motive power is distributed through the complex mechanism of countershafting, clutch pulleys, &c., involving a risk of hot bearings, broken pulleys, defective frictions, and what not, any one of which may shut down the whole station. Had these dynamos been each belted from an independent engine, the accidents above enumerated could not have occurred in the nature of the case. We do not assume to say but that accidents of some nature are due in any piece of mechanism; but the division of power and generating capacity into comparatively small units, each independent of all the others, affords a practical means of distributing the danger, so that it is essentially *nil* in its effects; that is to say, had a stoppage of any one independent engine in a similar instance occurred from any cause, the other engines, with their dynamos, would easily have distributed the load for a short time, without any disturbance or danger whatever, and the service would have been uninterrupted while the repairs were being made or the difficulties remedied.

It has been incidentally remarked by a gentleman familiar with the practical operation of a station, that independent engines afford a safeguard against danger from short circuits, inasmuch as currents of the short circuits will overload an independent engine and slow it down, thus giving warning of the danger. If the dynamo is driven from a single large engine,

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motive power will not respond to the short circuit until the short circuit becomes equal to the full capacity of all the connected dynamos plus the range of power in the engine. Practically, therefore, an engine of this type will not feel the short circuit, but will pull it through until something burns away.

The merit of the steam plant which is most obvious, and which appeals most strongly to the electric light company, is *economy of fuel*.

The advocates of large slow-speed engines rely upon the supposed superior fuel of this type as the sole effect to its obvious disadvantages. All managers unhesitatingly admit the superiority of transmitting the power directly and without loss from the engines to the dynamos, and more or less readily concede that in its performance the high-speed engine will also equal the running qualities and durability of the slow-speed engine. If with this, say they, we could get the steam efficiency of the Corliss engine, no man would hesitate to decide in the favour of the convenient, compact, and independent small engine. We take the question at once by the beard, and desire to state that, of two incandescent stations operating under ordinary circumstances, and otherwise equal, except only in their power and transmission, that one which has independent direct belted engines will show on its monthly report sheet, not a small amount, but from one-third to one-half less coal per lamp hour than a station driven from a single engine through counter-shafting, both types of engine being non-condensing. We go yet further, and state that independent non-condensing engines, under many conditions, will about equal in monthly coal account an equivalent slow-speed condensing engine. This is a fact so incontrovertible when actually and candidly investigated that we do not propose here to demonstrate, but merely to illustrate it.

We now submit the prompt inquiry, "Will not a high-speed engine use more coal per horse-power per hour than a Corliss engine?" Yes. "How much more?" Size for size, and load for load, not over 10 to 12 per cent. Score 10 per cent. against the high-speed engine, and again ask, "Will not several small engines use more steam than one equivalent large engine, even of the same type?" Yes. "How much more?" Load for load possibly another 10 per cent. Score 20 per cent. against the high-speed engine, and again ask how an admitted loss of one pound of coal in every five can be reconciled with the statement of a monthly saving of 30 to 50 per cent. in favour of independent engines? Answer, simply because we have to deal with conditions as they exist in fact, and not as we assume them to exist.

The reasons why independent engines can overcome their moderate lack of initial economy and pass a large percentage of actual economy to their credit are mainly two. First, the use of a counter-shaft implies power to run it. Indicator diagrams show that the real load of such a plant varies from 12 to 20 per cent. of the gross horse-power under full load when in ordinary good condition, and not infrequently rises to 30 per cent. and over, with badly lined shaftings and badly drawing pulleys. Moreover, it must be borne in mind that the dead loss is nearly a constant quantity, and if it amounts to 20 per cent. of the full load it will under partial load equal, and even exceed, the net power transmitted to the dynamos. It may easily happen, and doubtless does happen every night in every station thus far, that from midnight to morning two or three horse-powers are expended in the cylinder for each effective horse-power recovered at the dynamo pulley.

Thus, by one stroke and by a single item, is the conceded advantage of the larger engine reckoned in coal per horse-power practically swept away, and large and small engines left standing on an equal footing, prepared to submit to the still more searching question, "What is the cost from hour to hour of the power actually expended in meeting the fluctuation of the load?"

To consider for a moment some abstract facts in steam engineering, we must note that the steam engine develops its maximum economy (*i.e.*, minimum consumption) only over a limited range of its power. Under normal conditions of pressure, say eighty to a hundred pounds in the boiler, this minimum consumption is found only between the points of $\frac{1}{8}$ and $\frac{1}{4}$ cut-off, say from A to B (Fig. 1), at which latter point all engines are now treated. At its rated power, therefore, the single large engine of the Corliss type will consume as little as 26 to 28 pounds of water (steam) actually fed to the boilers per indicated horse-power per hour; and if the economy were not affected by the load, we could represent the rate of consumption by the straight line C D. If overloaded, however, the rate of water consumption rises, as shown on the right-hand portion of the diagram, in which the horizontal distances represent the actual points of water consumption; the curve, therefore, being a curve of efficiency at varying loads, it will now be particularly noted that, whereas the load rises for an overload, it also rises for an underload, and very much more rapidly. This is well understood to be partly from excessive condensation due to over-expansion, and partly from the greater ranges of leakage under short cut-offs. Considering Fig. 1 to represent the actual performance of a 400 horse-power engine at varying points of cut-off, it will be seen that the engine can be at its best only over a limited range, from A to C, or say from 325 to 450 horse-power. An overload is, of course, mechanically injurious which limits the possibilities in that direction. As the load falls off below one-fifth cut-off, the steam rate increases at an enormous ratio, so that at 200 horse-power the engine is using 50 per cent. more than its normal rate; *i.e.*, at 200 horse-power it is actually using the gross amount of steam which would give 300 horse-power if used in a 300 horse-power engine. At 100 horse-power waste is fully 100 per cent., and the steam used should develop, not 100 horse-power, but 200 horse-power if used in a 200 horse-power engine. It must be borne in mind that the diagram is plotted from observed facts, and is not a diagram of theoretical deductions.

It now remains to determine if the conditions actually obtained in electric lighting stations are such as will enable a single large engine to develop its normal economy; and, if not, then are they such as will enable the smaller independent engine with a lesser initial economy to reach a better gross result under the inevitable conditions as they are found to exist.

The typical daily chart of amperes delivered from an incandescent station of, say, 4,500 lights, is shown in Fig. 2, of course with variations in different stations, but always of the same general character. The chart is assumed to cover a winter night's run, commencing at 4 p.m., and shutting down at 8 a.m. The heavy, irregular line, A B, represents the fluctuation of the actual load, such as would be determined by indicating a series of independent engines; and the area enclosed between it in the base line, M N, may be denominated by the net power required. The fine, irregular line, C D, encloses the gross load when driven by a single large engine, being equivalent to the net load plus the friction of the shafting and pulleys required in transmission. The irregular band lying between A B and C D, therefore, represents the dead load, which would be a dead loss, due to the friction of the shafting. But, as above shown, this is the full measure of the loss. We have already seen in Fig. 1 that an excessive underload requires a relative amount of steam which would be adequate to produce a much greater power if applied in an engine worked at its point of maximum efficiency. Combining the two diagrams, therefore, we would find a third dotted line, E F, which would clearly represent the actual steam consumption required to secure the net work A B. The irregular band, therefore, between A B and E F, represents the total loss expressed in coal; in other words, the entire area E F M N represents the lamps which should be got for the steam expended, whereas A B M N represents the lamps actually got for the steam expended. The loss involved is practically 50 per cent. of the total fuel in the whole night's run, which corresponds to observed results in stations whose fluctuations of load are about as indicated. Of course, there are stations in which the net load averages more uniform than that shown, and a better proportionate result would therefore be expected from the single large engine with countershafting. We believe it is safe to say, however, that there is no incandescent station which will get a load so constant as to secure the economy from a single engine equal to that which can be realised from subdivided power.

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We now contrast the performance of independent engines in the same station. The lower narrow band between the lines M N and *a a* represents the smallest dynamo, equal to a load of 650 lights. The remaining three bands between *a a*, *b b*, and *c c* represent the other dynamos, or successive loads of 1,300 lights each. At starting time, therefore, a 60 horse-power engine with its 650-light dynamo is started, and run con-

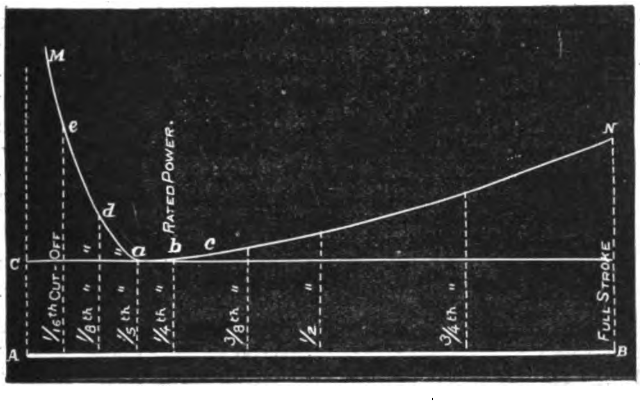

FIG. 1.—W. L. Church's diagram, giving efficiency curve of a 40 horse-power variable cut-off engine.

EXPLANATION—LIMITS OF HIGH EFFICIENCY.—Between *a* and *c*, or 325 to 450 horse-power. All other loads above or below these points show rapid fall in efficiency, *i.e.*, rapid rise in rate of steam consumption. The point *e* in the curve shows rate of steam consumption for 100 horse-power, while *d* represents that for 200 horse-power on the 400 horse-power engine. The diagram being plotted from observed facts, shows conclusively that such an engine can be run with high efficiency only between loads *a* and *c*, a moderate range below and above the rated power.

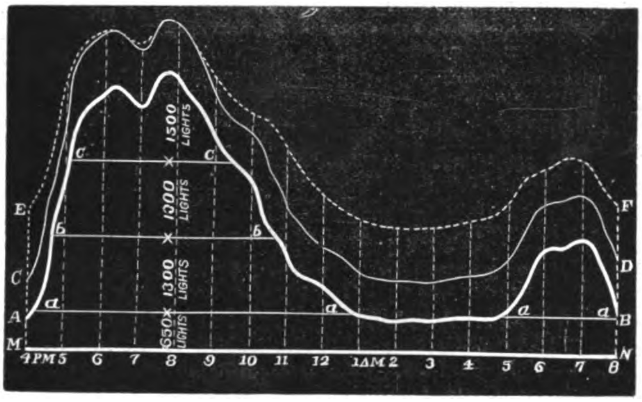

FIG. 2.—Church's diagram, based on actual performance in two stations, one operated by single large engine, and the other by independent engines.

EXPLANATION—WITH SINGLE LARGE ENGINE.—*A B* variable load between 4 p.m. and 8 a.m. *C D* gross load, including friction of transmission. *E F* steam consumption required for network *A B*. Area. *A B E F* = total loss expressed in coal = about 50 per cent. of total fuel used in the night's run.

WITH INDEPENDENT ENGINES.—One 60 horse power for 650 lights, two 125 horse-power for 1,300 lights each, and one for 1,500 lights.

The 60 horse-power engine is run at maximum efficiency throughout the night, indicated by *a a a a*. As load rises one 125 horse-power engine is started at 4:10 p.m., and driven at maximum efficiency till 11:45, and continued at lower efficiency till 12:45 (line *b b*).

Another 125 horse-power engine starts at 4:40 p.m. and runs at maximum efficiency till 9:30, and stops at 10:45, its last hour only showing falling efficiency (line *c c*). The fourth engine runs only from 5 to 9:30 p.m. at nearly maximum efficiency.

The contrast between the two methods of installation is most striking, as thus graphically represented. Each engine runs at its best range of efficiency, and only so long as its load is called for, then stops, and with it all consumption of steam, leakage, radiation, and wear and tear, and plenty of time is left for inspection and repairs if required.

tinuously until shutting down in the morning. It will be noted that, while running, the load on this engine is practically constant and at the point of maximum efficiency. In ten minutes after starting, the load rapidly increasing, it becomes necessary to start the second 125 horse-power engine with its 1,300-light dynamo, which engine again runs on its full and most [illegible]icient load, as indicated between the lines *a a*, *b b*. This engine is stopped at 12:45, and is therefore running to a disadvantage only for the last hour. At 4:40 the increase of light calls for the third engine with its dynamo, which in turn runs until 10:45, and is then stopped. The fourth engine and dynamo will start at 5 p.m., and run until 9:30. The point to be clearly understood as vital to the whole economic question is, that each engine while running is loaded to its best efficiency, runs only so long as its load is called for, then stops altogether, and with it all consumption of steam, leakage, radiation, wear and tear, and loss of every nature. Ample time is given to inspect the engines and dynamo if necessary, and the system as a whole develops the last possibilities of commercial efficiency.

The above diagram practically represents the performance of two stations which we once had the privilege of comparing. Both were practically the same size, and both were constructed on the same electrical basis. We were by courtesy put in possession of the monthly reports from both these stations, which showed a ratio between the pounds of coal per ampere per hour of 70 to 126 in favour of the station driven by independent engines. A station whose motive power is one or two large engines, therefore, finds itself in a position of earning money between starting time and ten o'clock, and spending it again between ten o'clock and the morinng.

We have thus endeavoured to make it clear in the above illustrations that the rated economy of the two types of engines is but a small part of the consideration, and cuts practically no figure whatever in actual practice under the conditions imposed by the nature of incandescent service.

If any one is now thinking to inquire, why not use a number of small Corliss engines in place of high-speed engines, if it is admitted that the Corliss type is more economical of the two, we would answer briefly, first, small Corliss engines are not as economical as small single-valve engines, the percentage of leakage due to the four valves and slower speed being much greater; second, small engines of the Corliss type run necessarily at so slow a speed as to preclude the possibility of direct belting, and to involve full lines of counter-shafting with their attendant cost and waste of power; third, the first cost of small slow-speed engines is very greatly in excess of that of high-speed engines of the same power. We think no one has ever seriously considered, however, the adoption of small independent slow-speed engines.

Next in importance to reliability and economy is uniformity, delicacy, and continuity of regulation.

There is much misapprehension regarding the matter of regulation in engines used for electric lighting. Let us, therefore, ask, What is good regulation? Good regulation implies, as a matter of course, reasonably small variation of speed, reckoned in R. P. M., between the engine fully loaded and the engine running light. Claims are made that such and such engines regulate to 2 per cent., 1 per cent., and even to one-half of one per cent., under variations of load. Now, it should be clearly understood, once for all, that any decent automatic engine controlled by the shaft governor can be so adjusted, not merely to 2 per cent. or 1 per cent., but to actually pass the point of exact regulation, and run faster under load than when light. So far as regulation in terms of R. P. H. is concerned, 1 per cent. or 2 per cent. regulation is sufficiently close for all ordinary purposes.

Second. The most important consideration in the regulation of engines in incandescent stations is not their variation from minute to minute, but from stroke to stroke. An engine may make 300 turns per minute, counted for each successive minute of the hour, and yet may at any given instant be running sensibly above or below this speed, in the effort to meet a momentary fluctuation of load. We say every engine may do this, and we have observed that most engines do this frequently; the difficulty being, not a matter of the construction of the governor, but purely a question of lubrication. A perfect governor is one which will maintain the speed, not at an average of 300 R. P. M., but at the rate of 300 R. P. M. for each and every stroke. Any properly constructed governor will retain the average of regulation to which it is set, but it can only secure instantaneous

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regulation when friction is practically eliminated. It has been our experience that nothing but a complete bathing of the governor in oil will practically accomplish this purpose and maintain its perfection throughout a long run.

Incandescent lamps require a regulation more delicate, perhaps, than any other industry. Any departure in regulation from stroke to stroke gives a variation of electromotive force, which is speedily destructive to the life of the lamp—the item which, next to fuel economy, is the heaviest taxation. The injury is done during the period of acceleration immediately following the change of load, which period is the time between the change of load and the movement of the governor; and this in turn is proportional to the friction. It is obvious that, if friction were annihilated, the acceleration would be also *nil*, and the speed, and consequently the electromotive force, would never vary.

Third. Under the extremely long runs now imposed by electric lighting service, continuity of good regulation is essential; that is to say, a governor which will regulate when well oiled, will fail to regulate when its pins and bearings, being inaccessible under motion, have become dry during a long run.

As to the nicety of regulation obtainable from a slow-speed engine, there is no comparison possible. We have already shown that it is not permissible for an electric light engine to vary its speed, even from stroke to stroke. A slow-speed engine not only may do this, but actually does vary its speed within the limits of a single stroke. All observers know that it is frequently quite possible to count the revolutions of a slow-speed engine, particularly when heavily loaded, by the pulsations in the lamps at a distance from the station. A slow-speed engine, unless excessive in its fly-wheel capacity, will imperceptibly slacken in passing its centres; and this variation, not visible on the engine, becomes a sensible and dangerous variation when multiplied to the speed of the dynamo. The fluctuation of the needle of two voltameters, respectively registering from a high-speed and slow-speed engine, will give abundant evidence on this point.

Flexibility.—The characteristic of flexibility in electric light stations is one which is frequently overlooked until experience demonstrates its desirability. To secure the best possibilities in this direction, it is necessary to use dynamos of two or three different sizes—say of 650, 1,300, and 2,500 lights capacity—each being driven direct from an independent. The plant being thus divided into independent units of different sizes in any variation of demand, either in the total load or in the load required for different circuits, can be conveniently met. Owing to local causes, the load of a station is not necessarily the same from day to day. It is obvious that a plant in which all the dynamos are hung upon one, or at most two, engines, is essentially rigid in its control of circumstances, whereas a station planned as above indicated is to the last degree flexible in meeting any variation of load, to whatever degree it may occur. All this has a direct bearing both on economy of fuel and incidentals of operation.

We would wish to imply that the smallest unit in every station should necessarily be the smallest dynamo—say, 650 lights. It is probable that the smallest unit is determined by the minimum load existing at any considerable time during the day. This minimum load in the majority of medium-sized stations will represent about one-eighth to one-sixth the generating capacity of the station—that is to say, a station of 4,000 lights capacity should have one dynamo at least as small as 650 lights. Beyond this, it is perhaps advisable that the units be uniform for the sake of interchangeability of parts. The whole question of units of generation must be considered, not in the light of any one rule, but under all the circumstances of each particular case.

Maintenance of Plant.—The maintenance account of a plant often defeats dividends in the use of counter-shafting, bearings, pulleys, clutch pulleys, belts, &c. No practical operator need be told of the repair account and general annoyance from the use of clutch pulleys. There are incidental exceptions, but we refer to the general rule. Each bearing of the counter-shafting will consume oil to the value of at least $5 per annum, and any considerable amount of shafting involves the pay of an extra oiler to properly care for it. Regarding the two types of engines under discussion, it is undoubtedly true that the maintenance of the high-speed engine will be fully as low as of an equal horse-power in slow speeds, as to its actual expense, without taking into account the time lost in repairs. Nearly all high-speed engines are made to gauge with more or less reference to interchangeability of parts. Repairs in consequence are furnished at a minimum of cost, and the parts being light and readily handled, the engine can be stripped and overhauled and connected up without the employment of an extra force of men, or the necessity of heavy handling. In referring to high-speed engines, we of course only speak of those which are carefully and understandingly designed for the work put upon them; that is, we wish to draw a sharp distinction between high-speed engines and engines speeded high.

Space Occupied.—This is one of the minor considerations which in certain locations becomes of considerable importance. Not infrequently electric light stations are located near the business portion of a city, where real estate is valuable, and taxes correspondingly high, and space counts heavily in the capitalised investment.

Again, a large building obviously increases the investment, particularly when we know that a building to carry heavy lines of shafting at high speeds must be of unusually massive construction. It needs no illustration to show that independent engines, by doing away with the space occupied by counter-shafting and belts under the least distance between centres which can be justified, require materially less space per horse-power than any form of non-subdivided power. This is particularly the case where the dynamos are placed on the second floor over the engine room.

Moreover, the cramped space in which the single engine must develop and distribute its power is against its satisfactory performance. The fact is generally overlooked, in drawing comparisons, that a single large engine in an ordinary manufacturing establishment, such as a cotton mill, has in the nature of the case a wide space in which to transmit its power from the slow motions of the engine up to the high speed of the spindles. This means that ample space is given to bring the speed, by gradual accelerations, through easy moving shafting of substantial nature, up to a moderately high intermediate speed, and then distribute it to the spindles in small quantities, by means of simple and light fast-running devices. In the dynamo room, on the contrary, the space is cramped to the last degree and the slow-running engine must, in short range, multiply its power to high velocities, and transmit its speed in large units to the dynamos. The whole system of transmission becomes rigid and ineffective, and the loss consequent upon friction, and risk to *employés*, and the magnitude of disaster when any occurs, are such as in themselves to overbalance all the ecomomy which the most enthusiastic advocates of slow-speed engines attribute to them.

Extension of Plant.—An electric light station, unlike most other industries, is usually of very rapid and persistent growth, to an extent which is not generally foreseen in the original calculations. The use of independent engines lends itself readily to indefinite extension. The power and dynamos both being divided into like units, each independent of all the others, extension becomes merely a question of more units, without any special preparation in the plan.

First Cost of Plant.—This consideration, although really of the least importance among those enumerated, is distinctly on the side of subdivided power. The price of the high-speed engine per horse-power is now fully as low and generally lower, than that of slow-speed engines. Cost of foundation is materially less, as is also cost of erection and handling for repairs. There then comes into the question the clear saving of all the money invested in countershafting, pulley blocks, heavy belting, clutch pulleys, pulleys, and similar devices. In the station to which we referred above, the extra transmitting devices necessitated the investment of a sum not less than $6,500. The price thus expended would be sufficient to purchase practically 500 horse-power of independent engines,

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adequate to generate 6,000 lamps, showing practically net earning capacity of at least $18,000 per annum. When we contrast this with the net losses due to the system of concentrated power, as above discussed, it leaves no room for argument as to the advantages of independent engines in electric light work.

A NEW PATTERN OF REFLECTING GALVANOMETER, WITH LAMP AND SCALE.*

BY G. L. ADDENBROOKE.

The instruments which I am about to describe are the outcome of improvements and modifications which have suggested themselves from time to time as the result of a good deal of experience in electrical testing for telephonic, electric lighting, and general experimental purposes. As usually constructed, the reflecting galvanometer is essentially a laboratory instrument, demanding care and skill for its management, besides being costly. Perhaps the greatest objections to it are, however, the difficulty of moving it and setting it up, and the time usually taken to put it right when it gets out of order. When, however, it is in good working order there is so much satisfaction in working with it that one returns with reluctance to the use of other instruments.

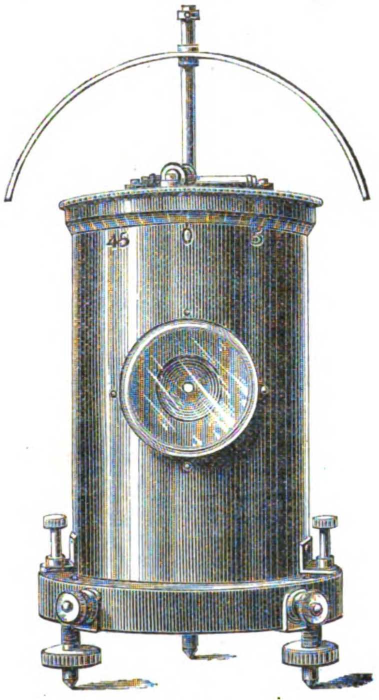

FIG. 1.

In the instrument before you it has been my aim, while preserving to the full the sensitiveness usually obtained in good laboratory instruments, to simplify and alter the construction, and thus fit it better for everyday needs, without at the same time diminishing its efficiency for the work with which it is now more particularly associated.

It is constructed as follows :—Fig. 1 shows the instrument complete. The base is circular and 5in. in diameter. The case is of brass, its top being 6in. above the base. The adjusting magnet, which is removed for carriage, rises 8in. further. The instrument is thus very small and compact. The adjusting magnet works up and down on its rod, a slot in the rod preventing lateral movement. Lateral movement is provided for by rotating the top of the case, which is marked with degrees so that the magnet can always be brought back to the same position again directly if it is necessary to move it. The spirit level or levels for setting the instrument are on the top of this lid. The case itself is provided with two L pieces at the bottom engaging in two screws with milled heads on the base. By giving them half a turn, and rotating the case slightly, it can be lifted off.

Fig. 2 shows the appearance of the instrument when the case is taken off. Rising from the base are two parallel uprights of ebonite ; four brass rods pass up through these, holding them in their places on the base, and forming the means of connecting the terminals with the wire on the bobbins. Further, there are four small thumb screws, which will be seen near the top of the ebonite uprights, two on each These screws pass through the brass rods I have mentioned, and into the outside cheeks of the bobbins.

The shape of the bobbins will readily be seen in the figure. The outside cheeks are left much thicker than the inside, and all the cheeks project about ⅛in. beyond the coils of wire. The lower halves of these projecting cheeks are cut away at the sides, as can be seen in the figure, leaving the upper portions projecting, so that the coils rest on the projecting portions on the ebonite uprights and slide exactly into their places. The cut-away portions of the thick ends of the bobbins are faced with brass plates, to which the ends of the coils are soldered. The thumb-screws above mentioned screwing into the brass plates complete the connections and hold the bobbins firmly in their places.

Both bobbins can thus be taken out in a moment without disturbing the needle ; there are no awkward connections to make or to get out of order, and if desirable several sets of bobbins can be made, wound with different lengths and sizes of wire to fit the same instrument, which can be interchanged without trouble at any time.

Now we come to the needle. The suspension is of quite a different type to that usually employed. A brass hoop will be observed passing over the centre of the bobbins and screwed at either end to the ebonite uprights. The whole galvanometer is put in the lathe and a very small hole bored centrally through this brass hoop. A V-shaped slot is then cut in the brass hoop from the front towards the back of the instrument, the point of the V-groove ending in the small central hole. About half an inch on each side of the hole two brass uprights are fixed ; they are forked at the top, and hold by friction a little ebonite rod with milled heads at each end.

One end of a silk fibre is attached anywhere on this rod, the other end is attached to the needle. The fibre may be a yard long if desired. The ebonite rod is then turned, winding the fibre round it until it (the fibre) is about the right length, and then the ebonite rod is slipped into its place.

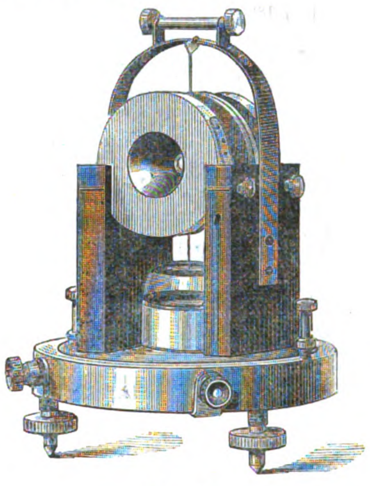

FIG. 2.

The fibre then, if it is wound the right way round the rod, at once automatically centres itself, and by rotating the rod the needle can be set exactly. By this means a long suspension is secured, and, if it is desired, several rods and needles can be kept for different purposes—say, one with damper for general use, and a finely-balanced astatic one for delicate testing, and a ballistic needle for condenser work. When the instrument has to be carried about a great deal spare needles, ready suspended, can be kept and be put in in a minute at any time should an accident happen. If the suspension of a needle does break it is often at a critical moment when time is important. To replace it is, as usually suspended, as, a rule, a long and tedious job. Much valuable time may therefore be sometimes saved by the use of a suspension of this character. It will readily be seen that attaching a new fibre is a very simple and short operation as compared with that necessary with the ordinary type of instrument. The needle itself consists of a stiff aluminium wire, carrying the magnets and mirror.

For all ordinary testing work I prefer to bend the lower end of the aluminium wire round into a loop and flatten it out. This makes an excellent damper ; it is sufficient to prevent long swinging and annoying vibrations without rendering the instrument dead and sluggish. This damper works in a little glass jar, fixed in the base of the instrument. The jar has its edges turned over to prevent the liquid being spilled when carried about.

* Paper read before the Physical Society, March 10th, 1888.

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It is, of course, easy to add a second pair of coils on the same principle as the two in the instrument before you should it be desired, but a constant of 1° deflection with 1 volt through 1,000 megohms can easily be got with a single pair of coils, which is more than sufficient for most purposes.

In using reflecting galvanometers a lamp and scale are required. All who have had experience in working with such instruments know that there is often as much trouble with the lamp and scale as with the galvanometer.

In the lamp and scale I have here I have tried, while securing the maximum efficiency, to reduce the whole within as small a compass as possible. The lamp itself consists of a copper tube about 12in. long and 4¼in. in diameter. The bottom of the tube forms the reservoir, the top portion acting as a screen. This tube is supported by guides at the sides attached to a metal base, which permit of the lamp being moved up and down through a total range of 6in.

In order to fill the lamp easily a funnel is provided in the top of the reservoir, with a tube attached, which reaches nearly to the bottom of the reservoir. In this way the lamp can be quickly and cleanly filled, and there is no need of a screw stopper to keep the paraffin from spilling or evaporating.

Most essential points in the construction of a lamp are that the longer axis of the flame and the axis of the lens or slot should coincide, and, further, that the intensest part of the flame should be opposite the centre of the lens. In this lamp, by prolonging the

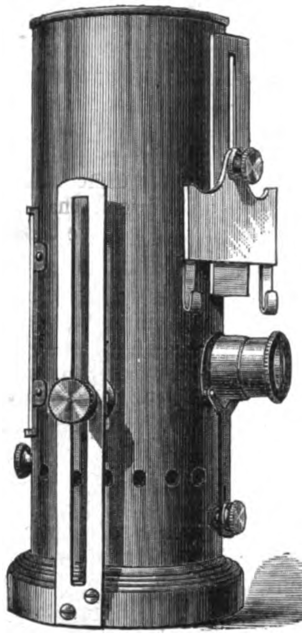

Fig. 3.

rod carrying the milled head for adjusting the wick and causing it to fall in a slot in the tube just below the door at the back, the longer axis of the flame is always kept in the proper place. Again, the height of the burner is carefully adjusted to be right when the lens is in a horizontal position. Further, to allow the lamp to be used in various positions, and with different instruments, the lens tube is made adjustable through a considerable angle, its axis of rotation being the centre of the flame. In this way a beam of light can be thrown upwards or downwards as well as in the horizontal direction. This is in working often a matter of great convenience.

For use with the lamp I have arranged a specially portable scale and shade. The scale itself consists of ½ a metre divided into millimetres. It is mounted on a thin board, as usual; this board is attached to a shade of the same length by long hinges. The whole is then cut through the middle, and a hinge fixed on the back of the shade. By this means the whole folds into half its length. Guides are fixed on the back of the scale, which engage in hooks fixed to a cross-piece on the front of the lamp, so that the scale slides easily backwards or forwards, and means are provided for raising or lowering the scale by itself, which is often convenient.

For carrying about or putting on one side, a box is arranged to take both galvanometer and lamp, with room for shunts and other accessories. The size of this case is rather less than is required for the ordinary pattern of lamp alone.

The maker of the instrument is Mr. J. J. Hicks, of 8, 9, and 10, Hatton-garden.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 3rd*, 1888.

THE CONVENTION AT PITTSBURGH.

It is thought by those who attended it that the recent meeting of the National Electric Light Association at Pittsburgh was one of the most interesting of the seven that have now been held by that body. The papers and discussions, which are all probably before you now, were generally marked by practicality, and gave the members many points to consider and work out in their stations and steam plants. Even where the topics were familiar and hackneyed, as in the case of underground wires, the evidence adduced by the speakers as to success or failure with burying the wires was most pertinent and valuable. The net result of the experience cited is that, while with incandescent lighting good work is being done with underground wires, including those in use on the alternating system, great trouble is still encountered with the high potential arc wires, no matter what precautions may be adopted. It was generally felt that to say arc wires could not be put underground was to make an unwarranted admission, and to limit the possibilties of the electrical arts; yet, on the other hand, few were ready to affirm that the satisfactory solution of the problem had been reached. The good point was made, too, that in this respect, judging from the numerous repairs of gas mains found necessary in every large city, and the many leaks which render the streets so odorous, our gas friends are, in fact, not so far along in overcoming the difficulties of perfect conduction as are electricians. It was further shown that the gas that thus escapes is one of the worst enemies underground wires have; and an explosion in the new telephone conduits at Buffalo came in time to emphasise the criticism.

The convention brought out a number of papers on the alternating current system of distribution which, together, present a number of facts, some of which are of decided interest at this time, when that method is becoming so prominent. The first paper read upon this subject at the convention by Mr. Philip Lange was devoted to the question of the general effect of powerful currents upon watches, and Mr. Lange showed, as the result of experiments, that the alternating current had no effect whatever upon the time keeping qualities of a watch; in fact, that the presence of the alternating current was conducive to the removal of any magnetism which might be inherent in the watch, produced by other causes. He described a ready method by which the watch affected with magnetism might be cured by simply placing it within a coil attached to an alternating-current circuit, and leaving it therein for a short time. This, of course, is a well-known experiment, which has often been applied to the demagnetisation of watches, but Mr. Lange laid particular stress upon the point that the alternating system provided a ready means at hand for watchmakers generally. Dr. Otto A. Moses drew attention to the fact that according to his view the continuous current on board ship was highly dangerous, as it affected the compasses, and thus made the steering of the ship unreliable; but Mr. Colvin, formerly in the U.S. navy, promptly replied that no such danger was to be feared from the direct current, and that experiments had conclusively shown that under many conditions tried on board the U.S. ship "Trenton" the running of the dynamo and lights had absolutely no detrimental effect upon the compasses.

In a paper "Upon the General Distribution of Electricity by Alternating Currents," by Mr. T. C. Smith, the author brought out some very pertinent facts in regard to this method of distribution, and asserted that there was absolutely no reason why in a properly constructed plant the converters should not be placed inside houses, and the secondary circuits be distributed therefrom. As regards the reliability of the converters to burning out, he said that of 600 converters of all sizes, from five to fifty lights, in an experience extending over twelve months of constant service there were only three actual cases of burning out, two of these being

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5-light converters and one being a 50-light converter. The two 5-light converters were simply slowly roasted out from overloading until the insulation on the primaries was charred through, when the fuses flew out and all was over. In the second case it was a 50-light converter which was affected by an overload, due to the negligence of some one who had, instead of placing fuses in the converter, connected them up with solid bars of copper. In his entire experience there had not been a single case of connection between the primary and the secondary, or the primary and the shell of the converter, even in the case of the burning out of converter. Mr. Smith stated that when the system was first installed by him it was customary to "bank" the converters; that is to say, to connect all the primaries and all secondaries in multiple and distribute from this one wire. But two or three peculiar experiences have led him to change this plan. In several instances one converter of the bank for some unknown reason would blow its plugs, thus overloading the others; then perhaps another would give way, and thereafter the rest would go in quick succession. His method now is to let each converter carry its own load independent of the others.

A curious thing remarked by him is that the wires carrying the alternating current do not blacken or collect dust upon the surface on which they run. Thus, in their station circuits at Pittsburgh, where they have both the direct arc and the alternating current side by side, the ceiling is painted in very light colours. The paint under the direct-current wire is found to be very dirty in the usual way, and the wires themselves are covered with black deposit; while the alternating-current wires and the ceiling against which they lie are said to be as clean as the day when they were put up. Mr. Smith laid particular stress upon the fact that with proper insulation the alternating high-potential system could be made as safe as any other.

Another very interesting paper was that of Mr. O. B. Shallenberger on the energy of alternating currents. Mr. Shallenberger showed that where considerable lag existed in the circuit a large part of the energy of the current was returned to the circuit, and though the indicating instruments might, under certain conditions, show a large consumption of current, the actual power measurements showed that the power consumed was far less than their indications would seem to show. He gave as examples several instances similar to the one brought out by Mr. Stanley some time ago, in which the voltmeter connected to an alternating circuit with an induction coil shunting a lamp showed a higher E.M.F. than a single voltmeter placed across the main wires. Mr. Shallenberger maintained that retardation of one-fifth of the phase restores one third of the apparent energy to the circuit, and beyond this point the proportion restored increases in a still higher ratio. This effect, however, would only take place when the load was very small or the secondaries were entirely open; but even with moderate loads that effect was not produced.

Visits were paid by many of the delegates to the Bentley-Knight electric road, which has been built up the steep sides of Observatory Hill in Allegheny City, across the river from Pittsburgh. This road ought to be popular, for in its tortuous windings it certainly answers to Coleridge's description of the road that human beings love to travel. This piece of enterprise has already been referred to in my correspondence, so I need not go again into details. I may remind your readers, however, that it is partly conduit and partly overhead. At present over two miles are in operation, with grades up to 10 per cent. In the more remote portion some of the rails in the new ground have spread; but that section will be ready, too, very shortly. It is worthy of note that, while provision is made for coal consumption, the generating plant uses natural gas as fuel, the cost being only 6s. 8d. per day, or 3s. 4d. for each car now in service, and proportionately less as new ones go into operation. This cheapness of fuel compares with that at Scranton, where the electric road is trying to consume the mountains of culm at the rate of 5d. per ton.

Among the attendants at the convention were Prof. George Forbes and Mr. Anthony Reckenzaun, both of whom participated actively, and were quite at home with their energetic American friends. It is said that both of them contemplate an early return to England.

The Institute of Mining Engineers has just held its annual meeting at Boston. Among the subjects brought up was the employment of electricity in mining operations, introduced by Mr. G. W. Mansfield, who was associated with Mr. Leo Daft in some of his earlier work, and is now connected with the motor department of the Thomson-Houston Company. Mr. Mansfield's paper dealt with the various items of haulage, telpherage, excavating, drilling, pumping, ventilating, &c., and created a very favourable impression. One of the speakers stated that in consequence of the success obtained by the Pennsylvania Railroad Company with the Schlesinger system in their Lykens Valley coal mines, it was the intention to adopt electricity also for the coal mines in which he himself was interested.

In this connection an important contract made by the Sprague Company deserves mention. It is the distribution of current for power on an 18-mile circuit, on the Feather river, Butte County, California, to drain the bed of the river, where gold untold lies in the pockets and shelves. A tunnel has been drilled 12,000ft. long, leaving the bed bare around three sides of a lofty mountain. To supplement the draining operations, electric motors are to be put in at fourteen places for pumps, hoists, &c., using for prime power the fall of 300ft. near the tunnel through which the river has been diverted. The apparatus has to be very compact, so as to allow of removal in case of sudden freshets from the mountain streams, and, as a whole, the work involves many difficulties calling for high engineering skill. It is understood that the Sprague Company will resort to potentials far above those it has hitherto used in its motor service.

Our literary periodicals have recently been paying to electricity the homage of their attention, and the outcome must be beneficial in a great many ways. Mr. Frank L. Pope has contributed to *Scribner's Magazine* for March an admirable article on "The Electric Motor and its Applications," and I hear that he is to have another, on the telegraph, in the April *Century*. Not to be behind, Harpers have just published in their *Weekly* an excellent and profusely-illustrated description, by Mr. Schuyler S. Wheeler, of some of the modern developments of electricity; and the *North American Review* has printed an article by a French writer on animal magnetism.

We are all watching with anxiety the course of the copper market, and while we can send no good news as to a fall in price will be very glad to be cheered up by any such intimation from your side. The statement is made that four of the largest manufacturers of copper wire for electrical purposes in this country used 13,500,000lb. of copper in 1887, while in 1886 their requirements were only $10,000,000.

I notice that the Wall Street papers are exercising their ingenuity over the sudden departure of Mr. George G. Ward, manager of the Commercial Cable Company, for Europe. Mr. Ward is so well known in financial and commercial circles that as soon as his trip became known, the newspaper scribes tried to find reasons for it in connection with the cable war. The current idea is that Mr. Ward is to take part in a conference to be held in London, in which Mr. Gould will also join, and from that it is argued that cable stocks are a "good purchase."

NOTES FROM PARIS.

(FROM OUR OWN CORRESPONDENT.)

In electrical circles, so far as talking goes, there is at present much animation, though very little actual work is being done. The Municipal Council still pretends to be well disposed towards electric lighting, but this is totally in opposition to the actual behaviour of the administration when any definite scheme is brought before them; in fact, the regulations for the laying of wires under the streets are so ridiculous that if they are not radically altered no distribution can be seriously undertaken. The general idea is that these difficulties have purposely been thrown in the way in order

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to prevent anything being done by private companies, the municipality intending by-and-bye to undertake the general lighting of the city on their own account. On Tuesday last a special committee of the council witnessed some experiments with the Gaulard-Gibbs transformers. Another experiment on a larger scale with the same system will be made in a few days at the Hotel de Ville. The council has already decided to erect a station of their own at the Halles Centrales for about 20,000 lamps, and it is highly probable that transformers will be adopted.

Most of the electrical papers publish in full the terms of the agreement made for the electrical lighting of the 1889 Paris International Exhibition. It can be briefly summarised as follows: The contract is made between the Ministre du Commerce et de l'Industrie and M. H. Fontaine, of the Gramme Compagnie; M. Lemonnier, from Sautter, Lemonnier et Cie.; M. Pol Tabry, of the Compagnie "L'Eclairage Electrique," and M. L. Rau, of the Edison Company, acting for the International Syndicate of Electricians.

About 1,500,000 candle-power will be provided, requiring 3,000 horse-power, the area to be lit extending over 300,000 square metres. The syndicate will receive as payment one-half of the amount taken at the gates in the evening, the entrance being fixed at 2fr. on week-days and 1fr. on Sundays. The capital is divided into 300 shares of 1,000fr. each, which are open to electricians of all nations. Every subscriber will have to erect an electrical plant equivalent to 10 horse-power, and to maintain it at work every evening during the exhibition. The motive power will be furnished by the syndicate. Any further information may be obtained from M. H. Fontaine, chairman of the syndicate, 15, Rue Drouot, Paris.

On the 1st of May next "the Restoration of the Bastille and the Rue St. Antoine," as they were in 1879, will be opened to the public. This exhibition will be lit with 1,000 incandescent lamps and 50 arcs. The motive power has been supplied by Messrs. Ransomes, Sims and Jefferies, of Ipswich.

The manufacture of incandescent lamps in France is being rapidly extended. The Woodhouse and Rawson Company have now got the works near Dieppe in full swing, and I hear that the Rothschilds Company will shortly undertake the manufacture of the Cruto lamp in Paris. Electric lighting in the provinces makes more rapid progress than in Paris, and before the end of the present year the towns of Montpellier, Perpignan, Marennes and some smaller places will be lighted electrically. The city of Havre has invited tenders for electric lighting to be returned by the end of the present month. The lighting of Mende, the chief town of the Department of the Lozère, will be started on the 1st of next month.

CORRESPONDENCE.

SAFETY DEVICES WITH TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the very interesting and able discussion of types of transformers given by Mr. Kapp in your late numbers, he credits Mr. Kent with having devised the simple apparatus of a "dividing sheet" grounded and placed between the primary and secondary coils of a transformer to intercept leakage from the primary to the secondary coil.

This "dividing sheet," or leakage shield, was, I believe, first described by me in United States Patent No. 322,138, dated July 14, 1885, in which patent there was explained the expedient of grounding the secondary itself to render them safe from leakage effects from the primary.

I quote from the patent as follows:—"It is not essential that the ground connection be attached to a secondary coil or circuit of a secondary coil, as it may be attached to a separate conductor, suitably interposed as a sort of diaphragm between the secondary and primary coils, although insulated from or in connection with the secondary itself." After reference to the figures showing the device, it goes on:—"The disc constitutes a metallic septum, insulated from the primary and insulated or not from the secondary; and by it any leakage from the primary, which would otherwise go to the secondary and connections, is intercepted and carried to the ground."

Near the close of the specification is the following:—"It is manifest that where, as in Figs. 2 and 5, the ground connection is made to a metallic diaphragm, interposed between the primary and secondary coils, an equally efficient, if not more efficient, protection from effects of leakage from the primary will be obtained." The patent fully describes the use and operation of the device in various forms.

As matter of interest in this connection, and as presenting a different protecting device, I may mention that in U.S. Patent No. 327,039, filed February 8th, 1884, I have described a connection of high resistance from the secondary to ground, in which connection is an electro-magnet, acting, when the primary leaks to the secondary and to earth, to cut off all connection of the local line with the leaking coil by a suitable switch. In this case the electrostatic capacity of the primary line and its unavoidable general leak will provide a sufficient current to earth through the switching magnet, when a connection has formed between the primary and secondary of a transformer. Prior to the production of such safeguards I never regarded inductional systems with high-potential primaries and low-potential secondaries as complete enough for practical use unattended with considerable risks.—Yours, &c.,
ELIHU THOMSON.

Lynn, Mass, Feb. 27, 1888.

THE SPECIFIC ELECTRIC RESISTANCE OF MANGANESE STEEL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: An editorial note published in your last issue (March 9th) displays so singular a lapse of editorial memory that perhaps you will permit me to call attention to it. You state that from a paper you publish "in this issue it will be seen Dr Fleming has determined the specific resistance of manganese steel, and finds it to be 3¼ times as great as that of German silver." If you will turn to your own columns for November 4th last, you will find you have already published precisely the same scientific fact, only in that case the determination was made by myself, twelve months prior to Dr. Fleming, and formed the substance of a paper read by me before the British Association at Manchester. You were good enough to reprint separate copies of my paper, one of which I enclose.

Dr. Fleming's paper contains a serious omission, as no mention is made of the composition of the manganese steel he used, which may contain from 12 to 20 per cent. of manganese, the resistance of the material varying accordingly. Otherwise his paper appears to be almost a transcript of my own, of the existence of which no doubt he was unaware. My determination gave rather a higher specific resistance than his, viz., 75 microhms (legal) per cubic cent. at 15° C., with a temperature variation of 0·136 per cent. for 1° C., through a range of 200° C.—Yours, &c.,
W. F. BARRETT.

Royal College of Science for Ireland,
Dublin, March 12, 1888.

[We usually rather pride ourselves on our recollection of everything that appears in this journal; but Jove himself nods at times, and on this occasion we must plead guilty to the charge of forgetfulness which Prof. Barrett brings against us. We can only add an expression of regret that we should have overlooked the paper read by Prof. Barrett before the British Association in September last.—ED. *E.*]

THE TEMPERATURE AT WHICH NICKEL BEGINS SUDDENLY TO LOSE ITS MAGNETIC PROPERTIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: When my paper bearing the above title was read at the Physical Society, Mr. Mordey asked a question which has an important bearing on the application of nickel to thermo-magnetic generators, and which I am afraid I did not at the time answer sufficiently. Mr. Mordey observed that in some experiments of his, after the withdrawal of the flame, a perceptible time elapsed before the nickel became magnetic. Mr. Mordey had evidently raised the temperature of the nickel too much before removing the flame. The metal should not be permitted to rise in temperature above a certain point, nor to fall below a certain point, if used for the purpose in view. With one of the specimens of nickel used by me the metal practically lost its magnetic properties at a tempe-

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rature which varied from about 340° C. to 400° C., according to the strength of the magnetising force. It *began* to lose rapidly its magnetic properties at about 300° C., and if I had been using it for a thermo-magnetic generator I should have endeavoured not to let the temperature fall below 300° C., nor to rise above 320° C. Between these limits the loss or gain of magnetic permeability was nearly proportional to the rise or fall of temperature, and was very considerable even for a variation of 1° C. Probably the best way of regulating the temperature in practice would be first to gradually adjust the burners with the machine at rest until the nickel has nearly ceased to be magnetic, and the temperature is fairly constant; then to allow the machine to work, and again to adjust the burners until a maximum effect is obtained. It is not necessary that the nickel plates should be very thin—they might be ½in. thick, or perhaps more, with advantage; but it would probably be better to use pure nickel rather than the ordinary nickel of commerce, as it would appear from the experiments which I have already made that for high magnetising forces the rate at which the permeability diminishes with rise of temperature above 300° C. is greater for the former than for the latter.—Yours, &c., HERBERT TOMLINSON.

BATTERY *v.* ALTERNATE-CURRENT TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I had more than one reason for not giving full figures in support of my argument in favour of "transforming by means of accumulators" at the recent meeting of the Society of Telegraph-Engineers.

I prefer to bring these figures forward in a paper of my own, where I should have the right of rejoinder after they have been thoroughly criticised by others. You are perhaps aware that I intend to deal with the subject in a paper I am to read before the Society of Arts in May, and I trust that the Council of the Society of Telegraph-Engineers will be able to find room for a short paper on the same subject during the present session, so that everyone interested in the subject will have ample opportunity of criticising my figures and forming his judgment thereon.—Yours, &c.,

March 12, 1888. R. E. CROMPTON.

SERIES AND PARALLEL TRANSFORMER CONNECTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Bernstein has pointed out to me that in the discussion of Mr. Kapp's recent paper on transformers I misunderstood his remarks (Mr. Bernstein's) on the question of the relative position of the mains in series and in parallel working. The passage was as follows:—"If they used transformers in parallel, they were obliged to use two main conductors, between which there was a very high difference of potential, say 2,000 volts; and they were, further, obliged to put them very close to each other in order to prevent induction on other wires. This made the insulation exceedingly difficult. Where they had transformers in series they only had the highest difference of potential at the dynamo end of the line."

Mr. Bernstein did not intend to convey that in series working it was less necessary than in parallel working to place the mains close together, but only that there was less danger of leakage or short circuit in the former than in the latter.

As I alluded to this point in my remarks, I gladly take the opportunity of correcting any misapprehension I may have caused as to Mr. Bernstein's meaning.—Yours, &c.,

March 14, 1888. W. M. MORDEY.

ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In further answer to Mr. Pollak's question in your issue of the 2nd inst., with reference to Prof. Ayrton's Patent No. 783 of 1881, we beg to say that that patent is at present controlled by us, and that we are well aware of its importance as covering all systems—whether in parallel or in series—that take current from "points of contact" instead of from continuous conductors, and thereby surmount many of the difficulties inherent to the latter method of transmitting power.—Yours, &c., ERNEST BERGHOLT,

Secretary to the Series Electrical Traction Syndicate (Limited).

11, Queen Victoria-street, London, E.C., March 14, 1888.

STREET LIGHTING IN ENGLISH TOWNS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Could you, without much trouble, furnish me with a list of all the towns in Great Britain which are using electric lights for lighting the public roads?

I have looked over many back numbers of your journal, but do not find what I want.—Yours, &c., J. O. S. ELMORE.

Bombay, Feb. 24th, 1888.

[We believe that the following brief list is a complete one:—

Taunton (Thomson-Houston system),
Hastings (Brush system),
Blackpool (Siemens system),
Waterford (Thomson-Houston system),
Exeter (Thomson-Houston system).
Eastbourne (Brush system).
Greenock.

There are, of course, a large number of private arc lights exhibited in the public streets.—ED. *E.*]

THE DE KHOTINSKY INCANDESCENT LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 2nd inst., in "Notes," under the title "Seel Lamps," it is remarked that "the method of manufacture of De Khotinsky lamps is kept secret for reasons easily guessed at." I will ask you to explain this suggestion, as the meaning of it is not clear.—Yours, &c.,

(CAPT.) A. DE KHOTINSKY.

Rotterdam, March 7, 1888.

[We have pleasure in complying with our correspondent's request, although our remark had no very profound signification, and we still think its bearing must have been obvious to most readers. We may premise, however, that we know absolutely nothing of the method of making the De Khotinsky lamp, and do not in the least imply that it is a copy of anyone else's manufacture. Still, the fact is undeniable that the lamp in question either is or is not novel. If it is new, then we think that the makers are well advised in keeping their methods secret rather than acquiring patents. On the other hand, if it is not new, or if there is any degree of uncertainty on that point—well, then they are following other well-known examples of a similar character. We repeat that there is no reason whatever, so far as we know, to take the latter view; but we hope we have now made our meaning perfectly clear.—ED. *E.*]

THE STABILITY OF TELEGRAPH WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: One last word with Mr. Caws. If he wants to know the practice of telegraph engineers with respect to temperature, elasticity and form of suspended wires, it would be wise to consult the text-books. One of the best is Douglas's "Manual of Telegraph Construction," where this question is thoroughly dealt with. The fullest and earliest is "Blavier" (1852), who even discussed the use of springs. Mr. Edwin Clark showed us, thirty-six years ago, how to ignore the coefficient of elasticity in our calculations. Perhaps, in time, Mr. Caws will even understand my tables—tables by which copper wire is being erected all over the world.—Yours, &c.,

W. H. PREECE.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: I agree with Mr. Higgins in his letter to your journal of last week upon the above subject. The burden of accumulated snow and ice upon the wires cannot of course be relieved by any kind of spring, but I think it would be worth while by such means as I have already suggested to endeavour to prevent the wires from chafing close up to the insulator. Mr. Higgins, I think, found as I did in the snowstorm of January, 1887, that the wires broke "short up;" therefore had rubber compensators been in use many wires would probably have been saved. In that storm the wind was not blowing upon the wires at a steady pressure, but came in severe squalls, causing shocks, and these shocks, having nothing to receive them except the weakened ends, at the insulator, caused the wires to give way; consequently the supports, through being relieved of their strains of the span, were torn from their position by the next span in the opposite direction.

In reference to Mr. Caws, I think it very bad form on his part to become personal when corrected; in fact, it is as great a mistake as his methods to determine the stability of a telegraph wire if possible.

My address I willingly append, not that I am desirous of any communication with Mr. Caws, except with your kind permission through your journal.—Yours, &c.,

ROBERT T. BOZON.

144, Kennington-road, S.E., 12th March, 1888.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Higgins is unquestionably right in arguing that in cases where the existing wire is stronger than its supports the line would not be rendered more storm-proof by still further strengthening the wire, and leaving the support as before.

It is not the vertical pressure of the snow-cased wires which brings down the supports; their collapse is attributable to the oblique transverse stress, which results from the vertical pressure of snow and wire compounding with the horizontal pressure of wind.

It is possible, for example, that in a 100-yard span a single copper wire of 100lb. per mile may be encased with 40lb. of snow, which, added to its own weight, would make, say, 46lb. dead weight per span. That snow-wreath may present a resisting area of perhaps 40ft. (measured normally to the direction of the wind), and the effective pressure of the wind may be perhaps 20lb. per foot (or very considerably more on rare occasions), so that the horizontal (wind) pressure would be, say, 40ft. × 20lb. = 800lb., while the vertical (dead weight) pressure would be only 46lb. The oblique (resultant) pull on the support standing between two such spans would (*if allowed to mature*) be $\sqrt{800^2 + 46^2} = 801$lb.; and it is to such oblique pressures (wholly or partially matured) that the collapse of the supports, which Mr. Higgins complains of, is due.

But wind is not a continuously uniform force. It moves in waves, whose period is greater or less in direct ratio to the velocity, and as the square root of intensity or pressure. The initial movement of each wave of wind is resisted by the inertia of the 46lb. dead weight; and, though this is followed by its own momentum, the duration of the wave of pressure may have been too brief to allow the catenary to be swung out to the full angle of deflection it would have reached had the wave pressure continued.

Electricians will understand me better, perhaps, if I say that, owing to inertia, the catenary, in deflecting transversely, lags behind the wind-wave which causes the deflection. If the wire were quite inelastic, and if the supports were absolutely rigid, the measure of lag would depend on the ratio of the weight moved (as the 46lb.) to the pressure moving it (as the 800lb), and on the period of oscillation due to the dip of the catenary. But with the elastic wire the lag is modified very materially by the extensions and contractions of catenary-length due to the alternations of wind force. Each extension and contraction needs time to mature; and if the period of the wind-wave is too brief to afford that time, the full extension or contraction, due to the alternations of wind force *per se*, is not permitted to mature. The smaller the lag the less the resistance, and the less the strain on the supports. It is easy to see that an elastic catenary has less lag than an inelastic one, and by its yielding to the wind it evades to a greater or less degree (according to the measure of its compliance) the *wrath*, so to speak, of the passing gust. It follows that, as there is less wind-stress thus resulting on the wire, there must, from the same cause (viz., the wire's extensibility), be correspondingly less wind-stress on the supports.

Therefore, the greater the extensibility of the wire, the greater the relief from storm-stress, not only of the wire but also of the posts or supports.

And inasmuch as, by means of spring shackles, a great importation of additional extensibility is secured, the supports benefit in the same measure as the line wire benefits.

Let us compare the telegraph post or support to the central stem or trunk of a giant elm or oak, and let us compare the wires to the branches. We know that the tree saves itself by bending to the blast. The trunk never bends so much as its branches. Some trees have trunks of extraordinary thickness and rigidity (as the finest specimens of the weeping willow, for example), but their branches are so extraordinarily supple as to fully atone for the want of suppleness in the trunk. Likewise if, through force of circumstances, the supports of a telegraph line cannot be made so supple as they ought to be, the spring-shackles will undoubtedly introduce the saving advantage of extra suppleness in the catenary, and of this extra suppleness the posts or supports will share the benefit to the full.

Moreover, by means of the spring shackle the insulation is so vastly improved that the same amount of conductivity as is now obtained from a 100lb. copper wire could be got from a lighter wire; and on the lighter wire there would be a lighter gathering of snow and a less wind force.

If I have not made my meaning clear I hope Mr. Higgins will write again.—Yours, &c., FRANK CAWS.

FIRE OFFICE RULES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At length the blow has fallen, and we have now another set of Fire Insurance Rules.

We have to-day seen a copy, and we presume that now not only will the Telegraph Engineers get out a set, but every individual insurance company will follow. What are contractors to do then? What will the public think? Surely if the society had only been content to adopt the well-known Phœnix rules, and embody them as their own (of course acknowledging their origin), all this trouble might have been averted.

Who can tell the amount of damage that will be done to our industry through the obstinate and irresponsible action of our presumably representative Society?

If a poll had been taken of the society's members, or of the electrical trade, would not the verdict have been in favour of letting well alone, and giving to the Phœnix rules (which certainly have the merit not only of priority but of secured success) the authority of the trade's society?

These are burning questions, and certainly require the immediate attention of every

ELECTRICAL CONTRACTOR.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

FIRE TELEGRAPHS.

At the meeting of this society held on Thursday, 8th March, the President, Mr. E. Graves, in the chair, a paper was read by Mr. Von Fischer Truenfeld on "The Present State of Fire Telegraphy." The paper, although highly interesting and important, was of an entirely non-technical character. The author presented a large number of statistics bearing upon the subject, and tending to emphasise the importance of fire alarms in securing the early extinction of fires. Tables 1 and 2, with the remarks appended thereto, probably contain the most important figures.

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TABLE I.

London Fire Statistics.

Year.	Number of Points at which Fire Alarms can be raised.	Proportion of Alarm-Points to Inhabitants.	Percentage of Serious Fires.
1876	160	1 to 17,531	11
1877	162	1 „ 18,144	10
1878	163	1 „ 18,857	10
1879	170	1 „ 18,871	9
1880	218	1 „ 15,333	9
1881	233	1 „ 14,923	8
1882	271	1 „ 13,322	9
1883	407	1 „ 9,203	9
1884	470	1 „ 8,256	9
1885	510	1 „ 7,871	7
1886	603	1 „ 6,880	7

TABLE II.

Relation between Serious Fires, Proportion of Population, and of Lives Lost in British Towns.

TOWNS.	Years.	Percentages of serious Fires.*	Proportion between public alarm points and inhabitants. Beginning of first period.	In 1886.	Lives lost per 100 at premises on fire.†
Glasgow	1876-78	1·3	1 : 53,778	1 : 5,614	–
	1879-86	1·1			
London	1876-79	10·0	1 : 17,531	1 : 6,880	1·85
	1880-86	8·1			1·95
Leeds	1876-83	23·0	1 : 12,500	1 : 9,418	0·21
	1884-86	16·0			0·00
Bolton	1876-84	12·1	1 : 92,000	1 : 13,500	0·24
	1885-86	6·5			2·60
Nottingham	1876-81	1.8	1 : 140,000	1 . 15,600	0·00
	1882-86	3·9			1·60
Brighton	1878-80	19·2	1 : 15,425	1 : 16,250	0·00
	1881-86	3·0			0·00
Dublin	1876-81	6·9	1 : 49,265	1 : 16,813	1·07
	1881-86	5·4			0·32
Manchester	1876-81	6·5	1 : 22,279	1 : 20,754	–
	1881-86	6·6			
Liverpool	1876-81	19·1	1 : 27,421	1 : 21,178	–
	1881-86	18·8			
Edinburgh	1877-82	2·5	1 : 42,281	1 : 21,552	0·90
	1882-87	0·5			0·35
Salford	1876-81	6·0	1 : 24,982	1 : 24,562	1·05
	1881-86	5·0			0·00
Bradford	1876-81	31·7	1 : 21,715	1 : 27,427	3·96
	1881-86	27·9			0·00
Bristol	1876-81	7·6	1 : 32,015	1 : 27,614	2·54
	1881-86	6·0			0·00
Sunderland	1876-81	50·0	1 : 27,500	1 : 31,250	0·00
	1881-86	41·1			0·00
Oldham	1876-81	8·8	1 : 29,536	1 : 32,554	0·00
	1881-86	4·9			0·34
Hull	1876-81	64·5	1 : 65,000	1 : 33,300	0·00
	1881-86	64·1			0·00
Birmingham	1876-81	18·5	1 : 79,215	1 : 34,616	0·65
	1881-86	7·1			0·00
Sheffield	1876-86	▲	1 : 50,000	1 : 35,111	0·00
Cork	1877-81	44·4	1 : 80,000	1 : 80,000	0·00
	1882-86	50·0			0·90
Blackburn	1883-86	11·5	1 : 108,268	1 : 115,000	0·00

* Chimney and false alarms excluded.

† But not through accidents caused by drunkenness, upsetting of lamps, or such like causes, and not including men of the Fire Brigade.

▲ No classification obtained.

REMARKS.

Glasgow.—Street call-points were introduced in 1879. They are of Anderson and Munro's system. The "Lives Lost Record" does not sufficiently divide the causes of death. The low percentage of serious fires is due to the solid style of buildings, the stairs being almost wholly of stones.

London.—Street call-points were introduced in 1880. They are of the Exchange Telegraph Company's, Spagnoletti's and Bright's system.

Leeds.—Street call-points were introduced in 1884. They are of Somer's system. There is also telephonic communication between fire and police stations.

Bolton.—Street call-points were introduced in 1885. They are of Philips and Hurst's system. There are 72 cotton mills electrically connected with the fire-brigade station, which has also since 1882 been connected to the Telephone Exchange.

Nottingham.—Street call-points were introduced in 1882. They are of the National Telephone Company's system. There is telephonic communication between the fire stations.

Brighton.—No street-call points, but telegraphic communication is established between the whole of the police and fire stations. The Telephone Exchange is also utilised to a large extent for transmitting information of fire; but these Exchange call-points are not included in this list, although they have largely contributed to the reduction of serious fires.

Dublin.—In 1883 telephones were connected with the telegraph system, and they serve as street call-points, of which there were 12 in the year 1886.

Manchester.—No street call-points. "Serious fires" mean here such where 1-6th or more of the property was damaged or destroyed, hence the proportionately low percentage of serious fires. The official records of "Lives Lost" include persons accidentally catching fire, and the figures are therefore valueless for a comparison with the percentage of serious fires.

Liverpool.—No street call-points. No records of "Lives Lost" are kept. Up till 1882 17 fire stations were connected by telegraph. These stations are now supplied with telephones at a total number of 20 telephone stations.

Edinburgh.—No street call-points, but the fire stations are, since 1884, in connection with the Telephone Exchange. The very low percentage of serious fires is due to the substantial construction of houses and stairs, which are of stones.

Salford.—No street call-points. Stations are connected by telephone. "Slight fires" are here such as result under £2,000 damage. This explains the comparatively small number of serious fires.

Bradford.—No street call-points. The fire-brigade station is connected telegraphically with 7 police stations.

Bristol.—No street call-points.

Sunderland.—No street call-points. The fire stations are connected by telephone.

Oldham.—No street call-points.

Hull.—No street call-points. Fire and police stations connected by telephone.

Birmingham.—No street call-points. Till 1879 the fire-telegraph was in the hands of the police. The Gower-Bell telephone was introduced in 1881 for fire purposes only, and the National Telephone Company put an instrument at the chief fire station. At present police and fire brigade work the telephone on distinct lines.

Sheffield.—No street call-points. The fire station is in telephonic communication with the Telephone Exchange. The average number of fires for the last ten years has been 75.

Cork.—No street call-points. There is only one alarm-point at the only fire brigade station of the town.

Blackburn.—No street call-points. Only one single fire-brigade station. Serious fires where damages exceeded £1,000; all others treated as slight.

DISCUSSION.

Mr. S. SHARP said he would like to carry fire alarms much further, and bring self-acting fire alarms into all large warehouses, &c. He then described one which had been recently taken up by his firm, consisting of a small Bourdon gauge tube filled with ether, which made a contact when the ether was expanded by heat. He mentioned that one on the ceiling of a room 12ft. high was actuated in two minutes by lighting a dish of spirits of wine on the table.

Mr. CRAWLEY: A fire alarm box was recently sent to my firm, and as I thought it might be of interest I obtained the permission of the inventors, Messrs. Saunders and Brown, to place it on the table to-night. A number of the boxes at different points are connected in series on a single wire, and in each box is a pendulum which, when released by the handle being pulled, breaks and makes the circuit at a rate depending on its length—some two or three times a second in this one—no two pendulums on the same circuit having the same rate of swing. The line circuit, when it arrives at the station, passes through a high-resistance relay, a single-cell battery, and to earth. The circuit is always closed, except when broken by one of the pendulums at the posts. At each break the relay sends a strong current from a local battery through a series of as many electro-magnets as there are posts. Before the first magnet there is an iron pendulum of the same time of swing as the one in the first post; before the second magnet one corresponding to that in the second post, and so on. When the alarm is given it causes a series of breaks and makes which will cause the corresponding pendulum at the station to swing violently, while the others are practically unaffected. A bell also rings to call attention. As soon as the signal is received a strong current is sent to line which resets the pendulum in the box ready for the next call. If two boxes (or even three) call simultaneously, both receiving pendulums will vibrate, for though the circuit is often broken at one box when made at the other, yet when both *do* make together it is at such a time as to act on both receivers. A circuit of five of these boxes has been in use at Portland-road Fire Station for the last four years. Captain Shaw, however, has a preference for a system with a separate wire to each box, and of these there are some 70 instruments of Messrs. Saunders and Brown's design in use in London. The circuit is normally open till closed by the handle being pulled, it is then kept closed by an electro-magnet in the box. A short-circuiting bell then rings at the station, and an indicator drops; a short-circuiting bell also rings in the box itself. The circuit is then broken for a moment by the man on duty, and all is ready for another call. The bell at the box ceasing to ring acts as a "received" signal. Both these systems avoid all false calls from leakage or contact with other electric wires.

CAPTAIN SHAW also took part in the discussion, and expressed his high appreciation of the utility of street alarms. He thought possibly some improvement might be effected in the direction of minimising the possibility of giving false alarms, which were still a considerable source of trouble to the Brigade.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

3,215. J. W. OLDROYD. London. Improvements in electric incandescent lamps. March 2, 1888.

3,223. W. KINGSLAND. London. Improvements in secondary batteries. March 2, 1888.

3,230. F. C. ALLSOP. Bexley. Improvements in electric tramways and railways. March 2, 1888.

3,235. G. MOIT. London. Improvements in multipolar dynamo-electric machines. March 2, 1888.

3,286. G. L. ADDENBROOKE. London. Improvements in electrical measuring instruments. March 3, 1888.

3,303. H. H. LEIGH. London. Improved apparatus for registering the consumption of electric energy (J. L. Clerc, Paris). March 3, 1887.

3,312. E. TYER. London. An improvement in voltaic batteries. March 3, 1888.

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3,328. C. LANGDON-DAVIES. London. Improvements in electric contact makers and commutators. March 3, 1888.

3,359. E. F. LAW. London. Improvements in apparatus for operating or controlling type-setting machines, type-writers and the like by the aid of electricity. March 5, 1888.

3,371. C. K. FALKENSTEIN and S. SUDWORTH. An improved method of attaching the caps or covers of electrical fittings to their bases so as to form an air-tight joint. March 5, 1888.

3,483. F. T. SCHMIDT. Bradford. Improvements in electrical switches. March 7, 1888.

3,498. T. PARKER. Manchester. Improvements in and relating to alternating-current dynamo electric machines. March 7, 1888.

3,504. J. OLDFIELD. London. Multiple electric communication. March 7, 1888.

3,517. R. DISHER. London. Improvements in primary batteries. March 7, 1888.

3,535. W. B. FITCH. London. Improvements in electric conductors. March 7, 1888.

3,550. N. G. THOMPSON. London. An electrical regenerative battery. March 8, 1888.

3,557. C. W. HARTLEY. Sheffield. Increasing the light produced by electricity by a combination of bracket and shade concave. March 8, 1888.

3,567. T. HARRISON. Bishop Stortford. Electro-melodic action of organ and similar wind instruments. March 8, 1888.

3,590. J. G. STATTER. London. Improvements in electrical transformers and plates therefor. March 8, 1888.

3,593. R. WALKER. London. Improvements in the construction of cells or jars of electric batteries. March 8, 1888.

3,614. S. ZIANI-DE-FERRANTI. London. Improvements in dynamo-electrical machines. March 8, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

March 10, 1888.

3,158. P. EVERITT. London. Improvements in machines for giving currents of electricity on the insertion of a coin, token, or the like. March 1, 1887.

4,369. P. JOLIN. Bristol. Improvements in instruments for detecting and measuring electric currents. March 23, 1887.

4,635. C. L. BAKER and F. BRYAN. Manchester. Improvements in and relating to telephonic and telegraphic call apparatus. March 29, 1887.

5,140. W. H. QUARTERMAN. London. Improvements in galvanic batteries. April 6, 1887.

5,193. G. A. GRINDLE. London. Improvements relating to a system of generation and distribution of electricity. April 7, 1887.

6,267. A. C. COCKBURN and E. THOMAS. London. Lock switches for use in electric circuits. April 29, 1887.

6,590. W. H. SCOTT and E. A. PARIS. London. An improved magneto-electric cut-out. May 5, 1887.

6,621. J. D. F. ANDREWS. London. An improvement in electro-motors. May 5, 1887.

6,933. D. NICOLL. London. Improvements in the insulation and laying of electrical conductors and in apparatus for that purpose. May 11, 1887.

13,148. F. ROSS and A. FRANZEN. London. An improved method of and apparatus for producing rectilinear or rotary motion by the aid of electricity, chiefly applicable to the regulation of electric currents. September 28, 1887.

13,447. A. L. LINEFF and E. H. BAYLEY. London. Improvements in electric railways and tramways. October 4, 1887.

155. A. J. BOULT. London. Improvements in or relating to electrical turnstiles (O. Ehrling, Germany). January 4, 1888.

PATENTS SEALED.

March 2, 1888.

12,032. A. FEATHERSTONHAUGH, JUN. London. Improvements in electric incandescent lamps. September 22, 1886.

16,650. O. SHRIVAN and F. DVORAK. Prague, Bohemia. Improvements in electric apparatus for the control of watchmen. December 18, 1886.

16,879. W. S. STEUGES. London. Improvements in the transmitting and receiving apparatus of printing telegraphs. December 23, 1886.

16,120. E. TYER. London. An improvement in voltaic batteries. November 23, 1887.

March 6, 1888.

17,120. R. E. B. CROMPTON and J. SWINBURNE. Chelmsford. Improvements in dynamo-electric machinery. December 31, 1886.

3,998. F. J. CHARY. Paris. An improved apparatus for the application of electric light for photographic purposes. March 16, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

2,563, 1887.—G. STUART. Electrical primers. (Price 8d.)
2,598, 1887.—T. P. HEWITT. Electric gas lighters. (Price 8d.)
5,096, 1887.—G. KAPP. Dynamo-electric machinery. (Price 8d.)
5,583, 1887.—H. LIEPMANN. Galvanic batteries. (Price 8d.)
8,396, 1887.—A. J. MARQUAND. Electrical apparatus for preventing corrosion of steam boilers, etc. (Price 8d.)
100, 1888.—H. H. LAKE (Humans). Generating electricity. (Price 11d.)
623, 1888.—R. J. GULCHER and J. PINTSCH. Thermo-electric elements and piles. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

The Pilsen, Joel, and General Electric Light Company (Limited).

An extraordinary general meeting of the shareholders in this company was held at the City Terminus Hotel, Cannon-street, on Tuesday last, Sir Rawson W. Rawson presiding.

The SECRETARY (Mr. W. H. Trentham) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, the memorandum which accompanies this notice really anticipates what I have to say to you on this question. When we met in November I expressed a hope that there was an amount of profitable business before us which would enable us to recover to a certain extent the capital which had been placed in this Company, and to yield a satisfactory dividend for the future to our shareholders. Each day has increased our sanguine hopes in that direction. Any one of you who may have been present at the recent meeting of the Society of Arts, where Mr. Carpenter gave an account of the present position and prospects of electric lighting, or who may have seen the printed report of his address, will be satisfied that there is a largely and daily increasing desire for the use of the electric light. We had hoped that that would have extended from the establishments into which it is now introduced, namely, trading establishments, private residences, and public buildings to street lighting, where particularly lies our interests; but it is pretty clear that that part of the business is not likely to be largely extended for two or three years at least. Therefore our chief object is to aim at extending our business in the direction of private installations. Many of you must be aware that several of the companies at present existing are doing a considerable amount of work in that direction. There is the Grosvenor Gallery Company, which has a very extensive business; there is the House-to-House Lighting Company, which has been received most favourably wherever it has advanced its efforts; there is the Kensington Company, which has been established at South Kensington with Mr. Crompton's light, and there are the Storage and other companies carrying on a system of lighting from central stations which promise the best results to them; and we feel that we should be wanting in our duty to our shareholders by neglecting the opportunity which now presents itself, if we did not extend what we have begun in this direction, being confident that with the careful and economical management under which it is now conducted, we can derive a satisfactory profit for the money actually invested in our operations. That is the reason for our coming to you for a call, to enable us to carry out that extension. We have now had the experience of six years' operations. Three years of that experience came under the old system, and the old hopes of extensive street lighting and extensive operations throughout the country—in lighting towns, villages, parts of the city, and so on. But during the first three years we spent money in provisional orders, in expensive surveys, and in manufacturing operations which have led to the expenditure of our original capital, and to disappointment; but as regards our lighting of private and trading establishments, our operations have been most successful. For the last three years we have not had a serious failure, difficulty, or complaint. Those who first took our lights have taken more of them. In the case of Mr. Baker in Holborn, who was one of our first customers, we have extended to him our lighting from Holborn to Fleet-street. From our new establishment in Stanhope-street we have lighted his establishment in Tottenham-court-road, and we have the opportunity of a large development of house and shop lighting in that district. We believe, therefore, that we are acting in the interests of our shareholders in making a call to complete what we have begun so successfully, and to extend our trade so that we may increase the dividend which, unlike most other companies, we have been able for two years to give to our shareholders—a mere trifle, certainly, but still no loss. That explains why we ask for additional funds at the present time. The second point that I have to bring before you is an explanation of our proposal for writing down the capital of the Company. Our patents originally extended over two kinds of lamps—arc and incandescent. Our interest in the latter has already been destroyed by the Swan and Edison Company establishing their patents in this country, and the value of the Gatehouse patent has already been written off. Then, with regard to the arc, we have been in existence now as a company for six or seven years, and the patents upon which we have been acting must have existed a year or two before that time. I do not remember the exact date, but half of the fourteen years of the life of our patents has already expired. We have only, therefore, seven years more of our patents to run. We feel that we are bound to take that into account in the estimate of our assets. We should not be justified in maintaining these patents at

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the same value year after year. We may establish a certain goodwill that may be very valuable to us before the patents expire, and we may be able to prevent others from using our patents, simply because we may be able to make better lamps than anybody who would attempt to cut us out; we may be able to show our competency to make safe installations better with our acquired experience than any new rivals attempting to come into the field to oppose us; but, as Directors, we are bound to take into consideration what the value of these patents will be during the next seven years. That being the case, if we were to retain these patents, which we now value at £25,000—that is the figure at which they stand in our books—we should have to write off £3,000 a year for the next seven years. That being the case, we do not feel that we should be able to make such a dividend as would make it worth our while to continue the operations of the Company. Our profits would be swallowed up in simply keeping up the nominal price of our patents, and on that account we believe that it would be most advantageous to the Company to take as the value of their capital the money that is available for making installations under the present system such as the public desire. It is of no use our having patents which the public do not use; and we do not see, certainly for two or three years, the chance of the use of the arc lamp extending in Great Britain, or in those places where we hold the patent rights. The demand now is for many incandescent lamps and for a few arc lights. We possess the advantage of supplying to our customers one of the best arc lamps in existence, but we are obliged to provide ourselves by purchase with incandescent lamps to satisfy their wants, and the Directors, after having matureiy considered the matter, having no object in view but the interests of the shareholders (for I think you will all acknowledge that for three years we have been working with no other object but the general interests of the Company, having certainly a very small interest in undertaking the onerous duties of our post), wish to do the best thing for the Company; and we believe that what we now propose is the best thing to be done in the circumstances of the Company. If any of our shareholders see an objection to our policy which is insurmountable, and can offer a plan more conducive to the interests of the shareholders, we shall be most ready to adopt their views; but having had this matter under their most anxious consideration for a considerable time, the Board see at present no other course open to them but the one they suggest; and having consulted their legal advisers as to the best way of carrying out the measure they have brought forward this resolution, and request your acceptance of it. I do not think I have anything further to add; but I shall be glad to hear from any gentleman any suggestion that will be more profitable to carry into effect in the interests of the Company. I therefore, as a matter of form, propose this resolution:—

"*That if an order of the Court be obtained for confirming this resolution, the capital of the Company be reduced as follows:—*

"*(a) By reducing from £2 to £1 per share the nominal amount of the 3,517 shares of the Company of £2 each, which have been forfeited, and are now unissued.*

"*(b) By cancelling, as being capital which has been lost, or is unrepresented by available assets, the sum of £1 per share on the 24,483 shares of the Company of £2 each, with £1. 5s. called up thereon, being the shares numbered 1 to 28,000 inclusive, with the exception of those mentioned above in clause (a), and the sum of £1. 16s. per share on the 100 fully paid-up shares of £2. 5s. each, being the shares numbered 39,351 to 39,450 inclusive.*

"*And that the Memorandum of Association of the Company be modified so as to carry into effect this resolution.*"

Major SCRIVEN, in seconding the resolution, said that he would like, as a merchant, accustomed to accounts, to add a few words to what the Chairman had just told them. Some three years ago, when they started on a modified basis, the available capital from the sale of their plant—he did not want to go too far back in the history of the company—was only about £7,000, and on that amount they had earned a very fair dividend and profits. They now saw the chance of increasing those profits considerably, for which they required a small amount of extra capital, and, as the Chairman had told them, the Directors thought they should be wrong if they did not make the proposed call, and tell them that there was an opportunity of extending the business. But they were met with this difficulty, that if they called up further money they wanted to pay the shareholders a good return for it, and they had little doubt that they could do so, not only on the capital that they would call up but on the actual working capital they now had. The Chairman had explained to them that they could not in their opinion consider the value of the patent rights as a valuable or proper asset any longer. They might mix their patent rights and goodwill together, in which case it would perhaps not be so necessary to write them off provided their total income justified so large an amount as goodwill. Goodwill might be fairly purchased, if it was a sound business, at three or four, or even five years' purchase, but twenty or thirty years' purchase was not a proper asset in a balance-sheet for goodwill. Now if they wrote off this capital, not as lost, but as a non-valuable asset, which they saw was meant by the terms of their resolution, they would be able, he hoped, to show the shareholders a very large and satisfactory dividend on their reduced capital. Their shares at the present moment were at a nominal price. He fancied that any larger offer to sell would bring them to more than a nominal price—it would bring them to a very decided price indeed. He thought it was very much better to hold shares of the nominal value of 5s., paying probably 15 or 20 per cent. dividend, and see them rise to a premium, as they would, and be worth, say, 10s. each, than to have shares of the nominal value of £1. 5s. worth only 1s. 6d. That was really why the Board asked them to adopt the proposed policy. He was sure it was a sound one. It was, in fact, putting the capital of the Company at its real figure, and not deteriorating the property in any way whatever. If better times came round, and a good Electric Light Bill were passed, as he believed would be the case, and they had more scope for extending their patent rights and manufactures, those shares would go up in value in proportion to the profits earned. He firmly believed, as did the rest of the Directors, that not only was there no patent arc light equal to theirs, but he did not think it possible that one could be invented to beat it. He had thought so all along, and he still held that opinion.

Mr. JAMES FYFE adversely criticised the proposed policy of the Directors, who, he further maintained, had shown a remarkable inaptitude for carrying on the business of the Company. He did not believe that their property had deteriorated in value as the Board seemed to make out, and protested against their calling out stinking fish in the face of the whole world when other electric lighting systems were doing so well. He went on to show that in consequence of the reduction of the price of the Company's shares in November last two of the Directors (Major Scriven and Mr. Whately) had became disqualified to sit at the Board, and said that clearly the Directorate was utterly unorganised, and had been in reality non-existent for more than a year, and therefore could not, in point of law, carry out the policy they now suggested.

A SHAREHOLDER asked how many shares the Directors held.

Mr. WHATELY: I hold 100.

Mr. FYFE: Major Scriven and Mr. Whately both hold 100 shares, but that is not a sufficient qualification.

Mr. HUTTON: They must have a legal qualification.

Mr. FRANCIS S. SAMUEL: What is the legal qualification

The SOLICITOR: £250.

The CHAIRMAN said that the qualification was not determined by the number of shares they held, but by an amount of money, and that was £250, as they had just heard.

A SHAREHOLDER asked how long the Directors referred to had been deprived of their legal qualification.

Mr. WHATELY replied that it must have been since the shares were reduced last year. Personally, he was very pleased to learn the fact for the first time. At the same time, he must remind the meeting that he and his colleagues had worked very hard for the benefit of the Company. It was due to both them and himself to assure the shareholders that they had not sold any of their shares in the Company.

Mr. SAMUEL contended that as they had not been able to live with £7,000 there was no reasonable prospect that they would be able to live with £14,000. The arc light that they possessed was a very good one, but they could not do a practical business against the companies recently established with large capitals on so small an amount as they now possessed or would possess by the scheme presented to the shareholders. He therefore suggested, under the circumstances, that they should by tender sell their rights as a going concern to one of the larger existing companies, and thus secure the largest amount of money possible for their rights and property.

Mr. GILBERT concurred in this view of the case, believing that the capital at the command of the Company under the proposed arrangement would not be sufficient to enable them to do a business that would be profitable to the shareholders.

Mr. BENEDICT also endorsed this opinion, and thought that it would be folly to throw good money after bad.

Mr. FYFE thought that it would be premature to adopt the suggestion of Mr. Samuel, and sell the Company's interest, believing that they had a much more valuable property, in view of the growing demand for the electric light, than the Board were inclined to believe.

After a brief discussion as to whether the business of the meeting might be legally carried on in view of the fact of the disqualification of the two Directors named,

Mr. FYFE moved as an amendment to the original resolution:—

"*That this meeting be adjourned for a month, and that a committee of shareholders, consisting of Messrs. Hopkins, Gwynne, Hutton and Fyfe, be appointed to investigate the statements contained in the notice convening the meeting, and confer with the Chairman and late Directors, and to report thereon, and generally upon the business of the Company, at such adjourned meeting; that the secretary be directed forthwith to issue notices for a general meeting to appoint Directors in the place of the Directors disqualified, and that in the meantime the Chairman and the secretary be authorised to continue the business.*"

The Chairman and other Directors having expressed their approval of the amendment, it was put to the meeting and carried unanimously.

NEW COMPANIES REGISTERED.

CHARLES L. BAKER AND COMPANY (LIMITED).—Registered by Rowley and Co., 3, Great Winchester-street, E.C., with a capital of £25,000. Object, to acquire on the terms of a provisional agreement, dated the 19th of November, 1887, and made between Chas. L. Baker of the one part and Frederick Murgatroyd of the other part, with such modifications (if any) as the directors of the company may think fit, the business of the firm of Charles L. Baker and Co., telegraphic, electric, surgical, and scientific apparatus makers, of Worsley-street, Chester-road, Manchester, as a going concern, including or together with the goodwill of the said business, the right to use the style of the said firm, and all trade marks used in the said business, and the benefit of all pending contracts entered into by the said firm, and the lease of the premises in Worsley-street aforesaid, occupied by the said firm, and all patent rights, plant, utensils, stock-in-trade, work in progress, patterns, drawings, electros, fittings and effects owned by or belonging to the said firm in connection with the business. The first subscribers are:—

	Shares.
C. Baker, Cornbrook Telegraph Works, Manchester	1
J. Johnson Bennett, Seymour-grove, Manchester	1
G. W. Locock, 2, Brooklyn-villas, Old Trafford, Manchester	1
T. Pilling, 2, Booth-street, Manchester	1
F. Murgatroyd, 2, Booth-street, Manchester	1
W. Penman, 6, St. Bees-street, Manchester	1
J. Witham, 72, Bury Old-road, Manchester	1

The first directors shall be James Leigh, J. E. Longson, Thomas Horsfield, W. B. Lowcock, Charles Sacré, John Hugh Penman, John Knowles Glazebrook, and Charles Laurance Baker. Qualification, the holding by each of at least 250 shares in the company in his own right. Charles Laurance Baker shall be managing director at a salary of £500 per annum.

ELECTRICAL WORKS CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—This company was registered on the 2nd inst., with a capital of £2,000 in £1 shares, to carry on business as electricians and electrical engineers. The subscribers are :—

	Shares.
R. C. Heywood, 101, Darenth-road, Stamford-hill, accountant	1
S. Graham Willmott, C.E., 42, Old Broad-street	1
M. Vinning, 33, Alexander-road, Hornsey, retired naval officer	1
C. J. Muller, 4, Hercules-passage, E.C., stockbroker	1
F. Belcher, 9, Warwick-terrace, East Finchley, accountant	1
H. A. Kidd, 27, Kempsford-gardens, Kensington, insurance agent	1
G. A. Grindle, 19, Great Winchester-street, electrical engineer	1

Registered without special articles.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED). This company was registered on the 2nd inst., with a capital of £100,000, divided into 19,980 ordinary shares of £5 each, and 100 founders' shares of £1 each, for supplying electric light and power in the district of St. James' or elsewhere in the metropolis. The holders of the founders' shares will be entitled to one-half the net profits remaining after payment of 7 per cent. per annum on the ordinary shares. The subscribers are :—

	Shares.
*Col. G. E. Francis, 55, Victoria-street, S.W.	1
*Latimer Clark, C.E., 6, Westminster-chambers	1
*E. M. Royds, Petersfield, Hants	1
*Peter Penn-Gaskell, J.P., 12, Albert-mansions, S.W.	1
Capt. E. M. Pallisen, 91, Earl's Court-road	1
Arnold Trinder, 47, Cornhill, solicitor	1
*E. J. A. Balfour, 32, Addison-road, architect	1

The number of directors is not to be less than 3, nor more than 8; the first are the subscribers denoted by an asterisk; qualification 100 shares; remuneration £1,000 per annum, or such larger sum as may be equal to 10 per cent. of the net profits, but not exceeding £1,500 in any year.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, being the same distribution as for the corresponding quarter of last year. The traffic receipts of this company for the week ended March 9th amounted to £4,668.

DIRECT SPANISH TELEGRAPH COMPANY.—The directors of this company, upon the accounts for the half-year ended December 31st, 1887, being submitted to them, have decided, subject to the audit of these, to recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend of 2½ per cent. (free of income-tax) for the half-year upon the ordinary shares, making, with the previous distribution, 4 per cent. for the year 1887.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The accounts of this company to the 31st December last show, subject to audit, a balance of profit of £121,800, after payment of three interim dividends. The directors now propose to distribute, on the 26th April proximo, the usual dividend of 2s. 6d. per share, making a total dividend of 5 per cent. for the year 1887. It is also proposed to pay a bonus of 3s. per share, or 1½ per cent., making a total distribution of 6½ per cent. for the past year, against 6 per cent. in 1886. The balance of £53,000 has been carried to the reserve fund, which now stands at £620,000.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended March 9th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,881.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half-month ended February 29th, 1888, amounted to £3,139, as compared with £2,840 for the corresponding period of 1887. The receipts for November, 1887, estimated at £5,236, realised £5,314.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Mar. 14, 1888.		Rate per Cent. Yielded.			Dividend Due.	Business Done during Week ending March 14, 1888.	
£			**TELEGRAPHS.**			£.	s.	d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	39	40	3	6	3	Jan., Apr., July, Oct.	39½	...
2,614,820	Stock	20/0	Do. Preferred	65	66	4	1	3	" "	66	65¼
2,614,820	Stock	nil.	Do. Deferred	14	15		...		February	14¼	13¾
130,000	£10	3/0	Brazilian Submarine	11⅝	12	5	16	8	Mar., June, Oct., Dec.	12 1/16	11 13/16
16,000	10	8/0	Cuba Submarine	12½	13	6	6	0	February and August	...	...
6,000	10	10/0	Do. Preference	18½	19½	5	5	3	" "	...	...
			Direct Spanish	3½	3¾		...			...	...
6,000	5	5/0	Do. Preference	8½	9½	4	8	0	April and October ...	...	...
60,710	20	2/0	Direct United States	8⅜	8⅞	5	5	3	Jan., Apr., July, Oct.	8¾	8⅝
380,000	10	2/6	Eastern	11⅜	11⅝	4	16	9	" "	11 9/16	11⅜
70,000	10	3/0	Do. 6 per Cent. Preference	14	15	4	1	4	" "	14⅞	14 5/16
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	4	0	0	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅜	12⅝	4	17	6	Jan., Apr., July, Oct.	12½	12 1/16
22,050	10	5/9	German Union Telegraph and Trust	8½	9½	6	9	9	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅜	5⅞	4	18	0	Jan., Apr., July, Oct.	5 13/16	5⅝
178,992	10	3/0	Do. 6 per Cent. Preference	13⅜	13⅝	4	8	0	" "	13⅝	13½
150,000	10	5%	Great Northern	13¾	14¼	5	5	6	Jan., July, and April	...	...
17,000	25	5%	Indo-European	38	40	6	5	0	April and October ...	...	...
			London Platino Brazilian	5	5½		...		...	...	...
9,000	8	4/0	Reuter's	7¾	8¼	7	6	3	April and October ...	8¼	...
338,225	Stock	15½%	Submarine	135	145	9	9	0	February & August	...	...
30,000	10	6/0	West Coast of America	5¼	5¾	8	13	9	January and July ...	5⅝	...
			Do. Debentures	111	116		...		...	...	...
88,321	10	nil.	West India and Panama	6	7		...		...	...	...
34,563	10	9/0	Do. 1st Preference	9½	10½	7	10	0	April and October ...	10¼	9 11/16
45,181	15	3/9	Western Brazilian	9¼	9¾	8	12	9	March & September	9½	9⅜
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120	125	5	12	0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101	103	5	15	5	March & September	...	...
			TELEPHONES.								
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	9/16	1⅛	5	9	0	Yearly	...	...
			Oriental				...		...	...	...
80,000	£5	5/0	United	13¾	14¼	4	16	3	June and December	14¼	13½
			United River Plate	5	5½		...		...	5⅝	5 1/16
			ELECTRIC LIGHT.								
	5		Anglo-American Brush (£4 paid)	2¾	3¼		...		...	3	...
23,692	5	nil.	Do. (fully paid)	3¾	4¼		...		February & August	4	3⅞
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅜	2⅝		...		...	2⅜	2¼
312,000	½	5% '87	Maxim-Weston	⅜	¾		...		February	...	...
			MISCELLANEOUS.								
37,350	12	36/0	Telegraph Construction and Maintenance	38	40	6	1	3	March and July	39½	38¾
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	15	17	5	17	8	February & August	16⅝	16¼

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THE ELECTRICIAN:

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NOTES.

If the County Government Bill should pass into law in the shape now before the House, the powers at present exercised by the Board of Trade in connection with the granting of provisional orders under the Electric Lighting Act will be transferred to the new County Councils. It may fairly be presumed that, on the whole, such a change would operate favourably upon the development of electric lighting. Time will certainly be saved, legal expenses would probably be diminished, and a wider local interest would be aroused in the undertaking. On the other hand, it may be feared that vested interests will have much influence in the provincial tribunals, and it is to be hoped that under certain conditions an appeal will be allowed, either to the Board of Trade or to Parliament.

We believe that the decision of the Supreme Court of the United States, upholding the validity of the Bell telephone patent, has given general satisfaction in this country. Apart from the personal interest which Mr. Graham Bell established for himself by his visit in 1877, the overthrow of his American patent would be felt as a great inconvenience here, unsettling the English patents, and offering encouragement to fresh litigation. The accounts of the judgment, which was delivered on Monday last, are very meagre; but it is reported that the case has been decided "on its merits"—a circumstance to be thankful for in every way, not more on account of the invention than of the inventor, whose *bona fides* was recklessly impeached by the promoters of this law suit.

In granting the interim injunction against the Equitable Telephone Company in the action brought by the United Telephone Company for an alleged infringement of the Bell and Edison patents, the Judge laid down a point of some importance in Patent Law. The contention of the defendant was, that by delaying to take action for nearly two years the plaintiff company had condoned the infringement, if any. But the learned Judge laid down that no action for infringement need be brought until actual damage is sustained by the owners of the patent. If a man, he said, threatens to cut down a tree on your property it is not incumbent upon you to take steps to restrain him before he actually swings the axe.

It seems a pity that the active and intelligent (and above all successful) electricians of America should be subject every now and again to be puzzled and misled by the publication of some apparently authoritative document containing the latest dictum of the native Professors of science (though "falsely so-called"). We venture to think that in calling attention to these performances we are rendering some service to our very numerous friends on the other side of the water. Our wrath has been moved at the present moment by the perusal of a paper "On Electromotive Force and Difference of Potential, by Prof. H. S. Carhart," in the *Western Electrician* of the 3rd inst. We there learn that "it is possible even to have a circuit through which a current is flowing without any difference of potential in it." As an illustration we are led to consider the case of a solenoid into which a bar magnet is thrust. Then follows this extraordinary statement, "the loss of potential in passing over any portion of the ring, due to its resistance, equals the gain due to the induction, provided the resistance of every portion of the wire is proportional to its length." May we ask the Professor to recollect that the loss of potential due to the resistance of the solenoid is a function of the *current*, and that the current may be varied indefinitely by varying the external resistance, without affecting the impressed E.M.F. in any way? *Verb. sap.*

In a letter which we published last week a correspondent made known the fact that "at length the blow has fallen, and we have now another set of Fire Office Rules." We regret to find that in certain circles the gravity of this announcement has scarcely been fully appreciated. We have even heard remarks of an unduly flippant character upon our correspondent's weighty phraseology. We beg, therefore, to express our opinion that this is really no laughing matter, although, happily, even at the eleventh hour, there is some reason to hope that the threatened state of anarchy may not be of long duration. Everyone will be relieved to learn that the Fire Insurance Committee of the Society of Telegraph-Engineers has at length brought its protracted labours to a close. We are still more pleased to announce that Mr. W. H. Preece, the chairman of the committee, has undertaken at an early date to read before the Society a paper, in which the whole subject will be treated historically and theoretically, as well as from the practical point of view. On this occasion a very full house may be confidently anticipated.

We have commented in our leading article this week on the glaring deficiency of the British Navy in respect to telegraphic signalling. Lord Charles Beresford intends to draw the

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attention of Parliament to an equally remarkable deficiency in the mercantile marine. Except to signal the name of the ship or for purposes of demanding assistance, the merchant service cannot communicate in any way with the ships of H.M. Navy The semaphore and Morse signalling systems of the latter are utterly unknown in the former. We agree with the late Junior Lord of the Admiralty that this lack of communication between vessels of the same nationality might be of serious consequence in time of war, and it furnishes one more argument in favour of popularising the Morse code.

THE publication of a Parliamentary return showing the receipts and expenditure on the Telegraph Service since its acquisition by the State has revived the old complaints of the excessive price paid for the businesses of the extinguished companies. It is pointed out, too, that whereas they made considerable profits, the Government has incurred and continues to incur considerable losses. The two complaints are inconsistent with each other ; but the fact is, that these yearly deficits are not due to the original cost of the business, but to the unremunerative tariff on which the Post Office was for 14 years compelled to work it. Whether the sixpenny rate will prove more profitable still remains to be seen. But it cannot be too often repeated that it is the public who demand these concessions from the State, and that if they do not turn out well the public and not the State is to blame.

IT may be hoped, however, that with this lesson before them the Government will take care not to pledge themselves to any heroic reductions of the tariff when asking Parliament for the money to purchase the submarine cables. The splendid revenue derived by the present owners is proof that the traffic will bear the charges ; and to reduce them unduly would be simply throwing away the one good chance remaining of acquiring a profitable business to set off against the loss on the land lines.

THE lecture delivered by Dr. OLIVER LODGE before the Society of Arts, on Saturday afternoon last, marks a very distinct advance in our knowledge of the phenomena of the lightning flash. It would indeed be difficult to over estimate either the beauty or the intrinsic value of the series of experiments performed by the lecturer on this occasion. It has long been known that the static discharge is of an oscillatory character, but the full signification of this fact has never before been so fully disclosed. Some of the experimental results obtained are remarkable, not only in connection with the subject immediately under investigation, but also for the light shed upon other problems of importance which are at present engrossing the attention of electricians. One experiment, for instance, gives, we think, conclusive evidence—if more evidence be required—of the existence of true magnetic lag, while at the same time it throws a new and very surprising light upon the important question of the magnetic permeability of iron under extremely rapid reversals, of which so very little has hitherto been known. The result is absolutely to upset our preconceived ideas in a way that, as the lecturer himself remarked, could not possibly have been foreseen. We are, in fact, led to the astonishing conclusion 'that iron is more suitable than copper for lightning-conductors, because *for extremely rapid current reversals it possesses a smaller coefficient of self-induction.*

IT is worthy of note that in the experiments on lightning protectors for telegraphic purposes which were carried out by Profs. HUGHES and GUILLEMIN as long ago as 1864, evidence which clearly admits of a similar interpretation was obtained. The experiments were almost identical with those of Dr. LODGE: a Leyden jar battery was discharged through a fine iron wire, and a spark discharger (or "lightning protector") was placed across its terminals. The result was that for powerful discharges "the fine iron wire was invariably destroyed, even with the best form of lightning protector" that could be obtained. The experiment was then varied by removing the lightning protector and joining the conductor direct to earth "by a copper stranded wire of 1cm. diameter," *notwithstanding which "with powerful discharges the wire beyond the protector was invariably burnt."* When, however, the copper wire was replaced by a thin sheet of the same metal complete protection was afforded. (*See* Prof. HUGHES' Presidential Address before the Society of Telegraph-Engineers, January 29, 1886, reported in *The Electrician* of February 5 following, page 257.) Prof. AYRTON has also, we believe, obtained evidence tending to show that with very rapid alternations the magnetic permeability of iron tends to decrease, but the fact that this decrease eventually leaves the total impedance of an iron wire very considerably *smaller* than that of a copper wire of the same length *and about five times the sectional area* was absolutely unforeseen.

WE beg to be allowed sincerely to congratulate Dr. SILVANUS THOMPSON on having foreshadowed this result a few weeks ago. Dr. THOMPSON'S precognition is the more remarkable because, as will be remembered, he determined at all hazards to avoid any consideration whatever for that particular term which now turns out to be the most powerful supporter of his thesis. We should scarcely be surprised to find that the Doctor was quite as much astonished at this result as anybody else. Nevertheless, we are happy to recognise his undoubted claim to priority in the restitution of iron to what now appears to be its true position as the lightning conductor *par excellence.*

WE shall take the earliest possible opportunity of publishing these lectures *in extenso*, and need therefore say no more at present, save only to add the remark that all the experiments were carried out by the most simple means, and anyone who possesses a Holtz, or a Wimshurst, or a Voss machine, will be able to repeat them quite easily.

MR. SYMONS' paper on the non-existence of thunderbolts, "illustrated by specimens," which was read on Wednesday evening before the Royal Meteorological Society, will be found in another column. The paper was admirable in tone and in intention, and was heard with much appreciation. We have not illustrated the specimens ourselves, for reasons which will be apparent on a perusal of the paper.

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It will be seen from Mr. Wilberforce's letter further on that the experiment recently suggested in these columns for obtaining a visible presentation of phase retardation has been tried at the Cavendish Laboratory, but without success. As Mr. Wilberforce points out, the inclusion of the Geissler tube makes the resistance of the circuit so great that at the rate of vibration of an ordinary make-and-break, the impedance is not much affected by shifting the core of the solenoid.

There can be no doubt that there is room for improvement and invention in the methods of covering wires for the purposes of modern electrical engineering. For submarine cable purposes the process has long ago attained perfection, but both for telephony and for electric light wires the requirements are of a different character, and it is impossible to suppose that finality has been obtained. Two novel and different processes are described in our columns this week, to which we would call the attention of those interested, without, however, expressing any opinion of our own on the merits of either.

We are quite able to sympathise with the wrath and indignation of an esteemed contemporary who last week published some information concerning a renewed attempt to float the Water Primary Battery Company, with a modest capital of £600,000. We are even prepared to take into serious consideration the proposal "to form an Association for the Abolition of Primary Batteries." But from the inquiries which we have instituted we gather that our contemporary has been misled. At any rate, M. Paul Raoul de Fancheux D'Humy has personally assured our representative that no such prospectus has been issued, and that he knows nothing whatever of any new proposal to form a company.

"The gas was extinguished shortly after the fire broke out." Such is the concluding item of intelligence which comes to us respecting the destruction of the Baquet Theatre at Oporto. That statement ought to stand first; for although the conflagration was the primary cause of disaster, the darkness was the ultimate cause of the fatalities attending it.

The Telegraph Offices of the World.—The *Journal Télégraphique* gives the total number of public telegraph offices in the whole world at 57,000.

Repair of the Suakin Cable.—The Eastern Telegraph Company announce that the Perim-Suakin Cable is repaired and communication with Suakin restored.

The Washington Capitol Struck by Lightning.—A Reuter's telegram states that the dome of the Capitol was struck on Wednesday last by lightning. The shock was severe, but no serious damage was done.

Dewsbury.—At a meeting of the Dewsbury Town Council, the Town Hall Committee agreed to communicate with electric lighting companies and contractors with a view of ascertaining the cost of lighting the Town Hall.

Proposed Cable from Spain to the Balearic Isles.—According to the Spanish journal *Industria e Invenciones*, the Government intend to lay a new cable from Spain to the Balearic Islands; the contract will probably be given to a foreign firm.

"Factory Accounts."—We are pleased to note that the excellent work on "Factory Accounts, their Principles and Practice," by Messrs. E. Garcke and J. M. Fells, has already reached a second edition. The publishers are Messrs. Crosby Lockwood and Son.

The Lighting of the Barcelona Exhibition.—The forthcoming exhibition at Barcelona is to be lighted by 400 arc lamps. The contract has been given to the Spanish Electrical Company, but it is understood that they will enlist the assistance of several foreign firms.

The Electric Light on the Great Northern Railway.—The lighting of the Edinburgh express by Mr. Radcliffe's device (in which the dynamo is driven from the axle in the guard's van) has proved so satisfactory that several local trains are now being fitted with the plant.

Bell versus Drawbaugh.—In the long pending action to test the validity of the Bell telephone patents in America, the Supreme Court of the United States has decided in favour of the Bell Telephone Company on every point, although a minority of three judges were in favour of the Drawbaugh claims.

Festivities.—On Thursday evening last, Messrs. R. E. Crompton and Co. gave a dinner at the Holborn Restaurant to their past and present pupils, to which also a number of their friends were invited. The after dinner proceedings were of an interesting character; the musical portion of the programme was contributed by Messrs. Spagnoletti, Gatehouse, Harrison and Alabaster.

The Effects of Residual Magnetisation on Bismuth.—From a note in the *Comptes Rendus*, we learn that M. P. Joubin finds that in the magnetic field bismuth presents an effect of hysteresis similar to that of soft iron—that is to say, when supported by a bifilar suspension in a magnetic field, the amount of its deflection for a given magnetising current at any time depends upon whether the current has been increased or diminished to its present value.

Electric Traction.—An electric railway, about six kilometres in length, is to be constructed in the Department of Haute-Savoie. The line will start from the Etrembières, and passing through Monnetier-Mornicx, will terminate on the plateau of the Grand-Salène, at a little place called Treize-Arbres. From this plateau there is a magnificent panoramic view of the Jura Alps. The line is intended almost solely for the convenience of tourists, the population being very sparse.

The Electro-Harmonic Society.—The last smoking concert of the season 1887-1888 will take place at the usual *rendezvous* on Friday evening, April 6th. An innovation in entertainments of the kind will be made, a string quartette rendering of works by Mozart and Haydn taking the place of the usual glee party. Violin duets, which some decades since were so fashionable, but which are now rarely heard, will also be played, and the vocal element will be ably sustained by Messrs. Arthur Thompson and Robert Hilton, and Master Humm.

Copper.—The most noteworthy event for some weeks in the copper market (says *Bradstreet's*) is the official announcement that the Calumet and Hecla Company has sold its entire production for three years to the French combination. No restriction is placed on its output, which is likely to be enormously increased within a year or two. The February product was at the rate of 35,000,000lb. of ingot copper per annum. The price secured is about 13 cents, while the cost does not exceed 7 cents. This makes a clear profit of $2,100,000 a year.

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Telegraphic Mercantile Codes. — In another page will be found an advertisement of a series of Mercantile Codes which is of interest as having been compiled by telegraphic experts with special reference to the elimination of all words the telegraphic signals of which are liable in transmission to be mistaken for those of others words. In these days, when large firms spend thousands of pounds upon their Codes, it is important to have such a selection of words as will reduce the probability of errors to a minimum.

Royal Dublin Society.—The afternoon scientific lectures of this society are being given during the present week by the Rev. Gerald Molloy, D.D., on the subject of electric lighting. In the first lecture on Wednesday he dealt with the question how the electric current is produced, and explained the principle of the dynamo-electric machine. In the second lecture to-day (Friday) he will deal with the question how the electric current is made to generate light, giving some account of the action of electric lamps, their construction, and their history. The lectures are illustrated by experiments.

Edinburgh.—At a meeting of the Free Library Committee on Saturday Mr. Bryson, electrician, read the specification he had prepared for the electric light in the library. In this he made provision for 70 Swan or Edison incandescent lamps of 16 candle-power and 22 arc lamps of 1,000 candle-power each, the power to be provided by two engines of 30 horse-power each. He estimated the annual cost, including depreciation, at £400. 10s. 8d. After some further conversation, it was agreed to adopt the specifications lodged by Mr. Bryson, and to send the subject back to the same committee to take estimates.

Volunteer Submarine Miners.—The *Volunteer Record* says :—"The Volunteer Submarine Miners are to be styled 'Engineer Volunteers Submarine Miners, Royal Engineers,' whilst the Engineer Volunteers will be known as 'Engineer Volunteers Fortress and Railway Forces, Royal Engineers.' It may not be generally known that a committee has assembled, and already taken evidence upon the whole question of the formation, instruction, and drill of the force, and some important alterations in the regulations referring to them are not unlikely to be the result, and a large extension of the force is likely to be decided upon. It is probable that additional companies will be enrolled under the amended regulations."

Bishopsgate Ward Club and the Lighting of the City.—Mr. E. G. Cherry presided at the fortnightly meeting of the Bishopsgate Ward Club, at Crosby Hall, on Wednesday, there being a large attendance of members. On the motion of Mr. Watson Dyer, seconded by Dr. Holt, and after a lengthy discussion, in which Mr. Cherry, Mr. F. Dadswell, Mr. J. Collinson, Mr. M. H. Liverten, Mr. Roberts, and Mr. F. Nix took part, the following resolution was unanimously carried: "That, in the opinion of this club, the City of London should be lighted by the electric light, and this club further considers that no contract for that purpose should be entered into which does not give the ratepayers the power of compulsory purchase."

Refining Sugar by Electricity.—Some time ago a sensation was caused by the announcement that sugar could be refined by electricity. The Electric Sugar Refining Company in New York is now said to be getting its plant ready for manufacturing in Brooklyn, and it will use the process invented by Mr. Henry Friend. It is claimed that this system will convert a ton of raw sugar in two hours into perfectly hard white sugar at a cost of 3s. 2d. a ton, and that the company intends to turn out 3,000 barrels a day of crystallised sugar of various sizes. The capital stock is a million dollars, and there are 450 shareholders, including a number of those interested in the sugar business. The results in this case will be awaited with a good deal of interest.

Maturing Wines by Electricity.—M. Mengarini is continuing the investigations of Blaserna and Carpine upon the method of artificially maturing wines by the electric current. In his experiments a current of about four amperes (our authority, *Le Cosmos*, says 3·99 amperes *per hour*) was passed through the wine for periods of varying length. The electrodes, which are of platinum, become coated with a deposit which consists chiefly of albuminous substances. The proportion of alcohol was diminished by the formation of a small quantity of acetic acid, and also by evaporation. It is also probable that some of the alcohol was directly oxidised. The bouquet of the wine is developed almost exactly as if by lapse of time, and it was sensibly increased at every application of the current. The colour is also modified. There is also reason to believe that the wine is sterilised, so as to be incapable of further change; but on this point M. Mengarini is not able to speak positively at present.

Re-Determination of the Value of "v."—M. Himstedt has recently made a re-determination of the value of the ratio "v" between the electro-magnetic and the electrostatic units. He adopted the condenser method described by Maxwell in p. 776, Vol. II., of the "Treatise." In a series of fourteen experiments, very concordant results were obtained, the mean value arrived at being

$$v = 30{\cdot}074 \times 10^9 \text{ centimetres per second.}$$

This is slightly higher than the value hitherto assumed as most probable. From the mean of four determinations selected by Gordon as the most probably accurate $v = 29{\cdot}857 \times 10^9$ M. Himstedt has previously experimented by the condenser method of Ayrton and Perry, and obtained the value $v = 30{\cdot}14 \times 10^9$. The mean value obtained from ninety-eight experiments by Ayrton and Perry was $29{\cdot}8 \times 10^9$ (not $29{\cdot}4 \times 10^9$, as given by the author).

Exhibition of the Royal Meteorological Society.—The ninth annual exhibition of the Royal Meteorological Society was opened on Tuesday evening at the Institution of Civil Engineers, 25, Great George-street, Westminster. It is devoted chiefly to instruments connected with atmospheric electricity. There are various forms of electrometers, including those formerly in use at the Greenwich and Kew Observatories. Many patterns of lightning conductors are exhibited, together with models of churches, houses, chimney shafts, and ships, showing the various methods of protection. The Post Office shows a number of lightning protectors used for telegraph purposes. One of the special features of the exhibition is a collection of over 50 photographs of flashes of lightning. Many of these were taken during the great thunderstorm which occurred in London on August 17 last year There are also a large number of photographs of damage by lightning. The exhibition remains open till to-day (Friday). Next week we shall give an illustrated description of the most interesting exhibits.

Southampton.—The garbage and town refuse of Southampton is largely disposed of in a destructor. This means the generation of heat, which is turned to advantage in raising steam, and of which circumstance advantage was recently taken by the borough surveyor, Mr. W. B. G. Bennett, to carry out an interesting experiment in electric lighting. The dynamo used for the production of the electric light in connection with the Jubilee illuminations happened to remain in Southampton, and the borough surveyor obtained permission for its temporary use. At present the circuit supplies twelve glow lamps and four arc

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lights, each of 3,000 candle-power. The maximum capacity of the dynamo is equal to ten of the 3,000 candle-power arc lights, or 250 glow lamps. The arcs are placed on the Corporation Wharf, while the incandescents light the office, the wheelwrights' shop, the engine house, and the destructor. Beyond the outlay for the dynamo, and the necessary arrangements, there is practically no expense for the production of the electric light except that involved in supervision and attendance. The cost is stated to be considerably under that of the present gas lighting.

M. Cailletet's Electric Furnace.—M. Cailletet, whose name is so intimately connected with the liquefaction of the "permanent" gases, has recently been studying the behaviour of gases under high temperature and high pressure. For this purpose he has made use of an "electric furnace," of which the following description is given in the *Comptes Rendus*:—"This apparatus consists of a mass of steel, in which is a cylindrical cavity one-fourth of a litre in capacity; a kind of stop-valve with a screw thread closes the opening. Two copper rods are attached to the cover, one of which is insulated from it. The platinum electrodes are attached to these rods, and vary in form according to the kind of experiment which is to be made. Usually a closed circuit is employed, and the copper rods are joined by a platinum wire spiral. The current is furnished by accumulators, and the gas to be examined is forced in at high pressure through a capillary hole bored in the solid steel. The platinum is then brought to a white heat and after a more or less prolonged period the gas is withdrawn for examination. By means of a small window filled with a special glass it is also possible to observe what goes on within the furnace. In this way by the substitution of carbon for the platinum electrodes, the behaviour of the electric arc at high pressures has been examined."

The Paris Exhibition.—A meeting was held at the Mansion House on Friday last under the presidency of the Lord Mayor for the purpose of forming some body of a responsible character to organise the British Section of the Paris Universal Exhibition of 1889. It was stated that in response to an urgent appeal from the Director-General of the Exhibition the Lord Mayor, with the tacit consent of the Government, had undertaken to form a committee for the purpose. An executive council had been appointed, and great care had been taken to include representatives, not only of various branches of industry, but also of the chief manufacturing centres of the country. The amount of space which would be placed at the disposal of Great Britain and the Colonies would be about 150,000 square feet. The most important question for the committee was that of finance, and it was necessary to have a guarantee fund.—Lord Brassey said they were met to arrange for the adequate representation of British industry at the Paris Exhibition. The Government would not be officially connected with the Exhibition, and it was necessary, therefore, they should make arrangements for themselves. He moved "That this meeting pledges itself to promote the interests of the Paris Exhibition, and to use its best endeavours to secure an adequate representation of British manufactures."—Sir B. Samuelson seconded the motion. The motion was unanimously adopted. A vote of thanks to the Lord Mayor for presiding closed the proceedings.

Overhead Wires.—On Thursday last a conference of the delegates appointed by the various metropolitan vestries and district boards of works was held at the Lambeth Vestry Hall, Kennington, Mr. F. H. Fowler in the chair. The following resolutions were unanimously agreed to: "That, in the opinion of this meeting of delegates from the various metropolitan vestries and district boards of works, it is desirable, in the interest of the inhabitants of the metropolis, that as a general principle all telephone, telegraph, and electric lighting wire within the metropolitan area should be placed underground." "That the control of the construction and maintenance of all telephone, telegraph, and electric lighting wires in the parishes mentioned in Schedules A and B to the Metropolis Local Management Act 1855, should, whether within 15ft. of the surface of the road or not, vest in, and be under the direction of, the vestry and district board of the parish or district in which such telephone and telegraph wires are situate." "That, in order to prevent any separate vestry or district board refusing arbitrarily the passage of through wire across their parish to the detriment of other parishes, an appeal should be allowed to the Metropolitan Board of Works similar to that sanctioned by Section 211 of the Metropolis Local Management Act, with reference to the orders or acts of the vestry or board in relation to buildings, sewers, &c." "That, considering the serious invasions, not only of public but also of private rights, proposed by the Bill of the United Telephone Company, the various vestries and district boards be recommended to adopt the foregoing resolutions, and to oppose the Bill with a view to having the principles embodied in such resolutions incorporated in the Bill, and such other amendments as are detailed in the petition of the Metropolitan Board of Works against the Bill."

Dr. Silvanus Thompson on Electric Bells.—A very clear and interesting lecture was given on "Electric Bells" by Prof. Silvanus Thompson, at the Royal Victoria Hall, on Tuesday. Instead of yielding to the temptation of travelling hurriedly over a large space of ground, he confined his attention to this small department of electrical science, and explained it thoroughly. A number of experiments were shown, illustrating both permanent and induced magnetism, and a variety of forms of electric bell were exhibited, from very sweet-toned church bells of a small size to a contrivance intended to wake up servants, which, when once the button is pushed, goes on ringing incessantly till the tormented servant goes to the bell and pulls a handle. Dr. Thompson then went on to inquire where the power comes from to produce these results, for we can never have results without a cause. There is no such thing as "perpetual motion;" wherever we have power, something must be spent to produce it. Here it is clear the power starts from the battery. What is used up there? In ordinary steam engines we burn coal; in a gun the fuel is gunpowder; in a battery it is zinc. Zinc is combustible in air, though not freely so, and in a battery it is burnt in acid, the combustion going on while the current passes and the bell rings, but at no other time. There are methods of obtaining a current without a battery—for instance, by turning a handle and causing a coil of wire to rotate in presence of a permanent magnet. But the same principle holds with all. Something is used up to obtain the power. In this case, the man who turns the handle plays the part of engine, and the food which he has eaten is consumed to do the work. In the course of the lecture, Dr. Thompson spoke of the large extent to which electric power is used in New England, as many as two hundred shops in one town being supplied with it from wires laid under the streets, as our gas-pipes are laid. But for vested interests, he said, the same thing might be done in London, and power supplied to workshops with much economy both of space and money.

The St. Petersburg Lighting Exhibition.—We take the following extract from an article in *Money*, a journal

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which, however, is unmitigatedly hostile to the electric light:—"The 'Exhibition of Light,' or, as it is more commonly called, the Petroleum Exhibition, now being held at St. Petersburg, is of so instructive a character in regard to the progress of lighting of every kind, that it is a pity so few foreigners have paid it a visit. In practice is there demonstrated so clearly the opinions long maintained in *Money* respecting the ability of gas to hold its own against the electric light, that a few words about its display may interest its readers. The electric light has a section all to itself; the gas and the oil lamps are exhibited together. This has proved a bad arrangement in one respect, for when the hundreds of lamps and the hundreds of gas jets have been burning a couple of hours, the heat of the place is something infernal—often 100 degrees of heat F.—the temperature outside the Exhibition, into which the visitor plunges after quitting the building, being at the same time 20 degree below zero F.! However, Russians enjoy a contrast of this kind, and just now, when foreigners are not in favour, they have not the least objection to the Exhibition killing off as many as possible. The Exhibition is the creature of the Imperial Technical Society, and in general impartiality has been shown to every form of lighting. Kerosene or paraffin lamps are very well represented, and with respect to gas, there is hardly a new foreign patent which is not on view. The first impulse to modern electric lighting came, as is well known, from Russia, and since Jablochkoff made his first successful experiments in St. Petersburg, the Government and the municipal bodies of Russia, infinitely readier to accept new ideas and encourage inventors than the administration and local bodies of this country, have given it so much support that one would expect to find electric lighting very well represented, and in extensive use in Russia. The contrary, however, is the case. The Nevsky and two or three thoroughfares possess the light, and a few shops, hotels, and palaces are lit with it; but, generally, it is unpopular in Russia on account of its dearness—particularly in St. Petersburg—and, if anything, has rather retrograded than developed during the last twelvemonth. This retrogression is illustrated in the electric display at the Exhibition, which has a starved look about it, notwithstanding the favour shown it by the Imperial Technical Society. So unpopular is the light that it is a question whether the display has led to the slightest accession of business to the electric lighting firms. The case is very different with the display of gas and lamps. In both there are evidences of prosperity, of startling progress, and of improvements in cheapness and intensity of light that cannot but strike the most indifferent observer."

Proposed Electric Lighting for Torquay.——A meeting was held last week in St. George's Hall, Torquay, for the purpose of hearing an address from Mr. W. Radcliff, of London, on the advantages of electric lighting and the advisability of forming a limited liability company to promote this means of illumination at Torquay. Mr. Radcliff has successfully introduced the electric light on the stage of Torquay Theatre. The chair was taken by Mr. C. P. Henderson, and, although the attendance was not large, most of those present were tradesmen and showed much interest in the subject. It appeared, from Mr. Radcliff's remarks, that his proposal is only to introduce the electric light into houses and business premises, and not into the public streets, and to supply the area from Wood's Temperance Hotel at the top of Lower Union-street to the Queen's Hotel on the Strand. After giving facts and figures with a view of explaining the advantages of electricity, he pointed out that by carrying out the proposal to light houses only, they would avoid all the complications of the Electric Lighting Act, which, however, was being rapidly altered so as to meet the views of electricians generally. Dr. J. B. Richardson spoke of the injurious effects of gas on the system, and how it tended to produce consumption and other diseases, and he advocated electricity not only as a better illuminant than gas but because it would be the means of improving the health of the town. He had no doubt that, if the Gas Company could pay 10 per cent. dividend, an electric lighting company could be easily made to pay the same.—Mr. Radcliff said there would be no difficulty in raising the necessary capital in London, but by forming the company and supplying the electric light locally they would be getting it at cost price. He offered to put up the whole of the plant, and superintend its erection for a term of three years free of all professional charge whatever on condition that he received £50 a year for every 1 per cent. dividend which the company paid. He did not propose any particular system, but to use what was best in all of them.—Mr. O. S. Bartlett, solicitor, explained the legal formalities to be complied with in the event of its being decided to form a company. There were three methods—one by obtaining a license of the Board of Trade, the second by obtaining a provisional order, and the third by acquiring an Act of Parliament. He suggested that consideration should be confined to the first two methods. A license could only be obtained by first getting the consent of the local authority, and it expired at the end of fourteen years. Under a provisional order the company would be protected for forty years, at the end of which time the local authority would have power to purchase the plant and machinery. Under an order nothing could be done except at certain periods of the year, but with a license they could proceed at once. In either case a deposit of £50 would have to be made with the Board of Trade, and the expense of getting an order would be little more than that of obtaining a license. They should first get the order or license, and then form a company to raise the capital and carry out the works.—Mr. Radcliff, in reply to questions, said that the electric light could be sold at the rate of ½d. per hour for every 20-candle lamp, whilst the meters were absolutely accurate. (Laughter.) A capital of £12,000 would be sufficient for providing the plant for lighting the houses in the streets from Wood's Hotel to the Queen's. This was about one-half of what would be required from other companies, owing to the fact that they would have to pay no promotion money, and they would get their engineering done for nothing until they began to pay a dividend. He only proposed to light the main streets, and not the side streets. The wires could be laid along the copings of the houses.—Mr. Callard feared that there would be a difficulty in getting the consent of the Local Board to carrying wires overhead, whilst he questioned whether the proposed area was sufficient to ensure a remunerative dividend on the capital mentioned. He proposed that a committee be formed to go into the question of cost, and also the sightliness of the wires, before they took any initiatory steps for the formation of a company.—Mr. Radcliff replied that the wires could be laid in such a way as to be neither unsightly nor objectionable.—Mr. Edwards seconded Mr. Callard's proposition, and suggested an adjourned meeting. After further discussion, a resolution was carried, on the proposition of Dr. Richardson, "That in the opinion of this meeting it is desirable to form an electric light and power company, and that a committee be appointed to consider fully the necessary details and report to a future meeting." The committee was appointed, consisting of Dr. Richardson, and Messrs. Rockhey, Aitkin, Dendle, Edwards, Callard, Iredale, and Wood.

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THE FRANKFURT-OFFENBACH ELECTRIC TRAMWAY.

BY E. KRAUSE.

This tramway has been constructed on the main road between Frankfurt and Offenbach on the Main, and has been in continuous working during the last four years. Tram rails have been used and put down as an ordinary tramway line; the rails are level with the road pavement. The general aspect of the line is shown in Fig. 1.

With reference to the map shown in Fig. 2, it will be seen that the electric tram line starts from the Charlemagne Bridge, in Frankfurt, and goes along the Sachsenhausen bank of the River Main; leaving the suburb behind, it passes through the village of Oberrad, which is situated about half-way of the whole line, and here has been erected the central station for the generation of the electric current. Leaving the village the tramway winds its way along the road and enters Offenbach at the west end, and traversing the town and market place it terminates at the Matilda-place. The whole length of the line is 4·14 miles. An extension of the electric tramway to the village of Buergen may in time be expected.

slotted at the bottom, as Fig. 3 in full size shows. The length of the tubes is 15ft., and they have been well bored out, and are therefore perfectly smooth and clean, so that the internal surface offers as little as possible mechanical or electrical resistance to the contact carriage sliding within. The tubes are screwed together by means of sockets in the usual way and then soldered. About 90ft. apart, but much closer in curves, wooden posts of the ordinary telegraph type are erected on one side of the road, on which cast-iron brackets, as shown in Fig. 4, are fastened. The brackets carry two iron-hooded insulators, on which the tubes are suspended by means of iron hooks. The posts are 18ft. high, and the tubes are arranged about 15ft. from the ground. To prevent the suspended tubes from sagging two stout iron-wire ropes have been stretched over insulators fastened on cast-iron brackets on the top of the posts all along the line, and the tube conductors are generally suspended twice between two posts, by means of clamps, to the ropes as shown in Fig. 5. The expansion of the conductors during hot weather will cause more sagging than in cold weather, when the conductors are almost straight; this, however, does not appear to give the least impediment to the moving contact carriage. The resistance of this tube conductor is only 1·6 ohm.

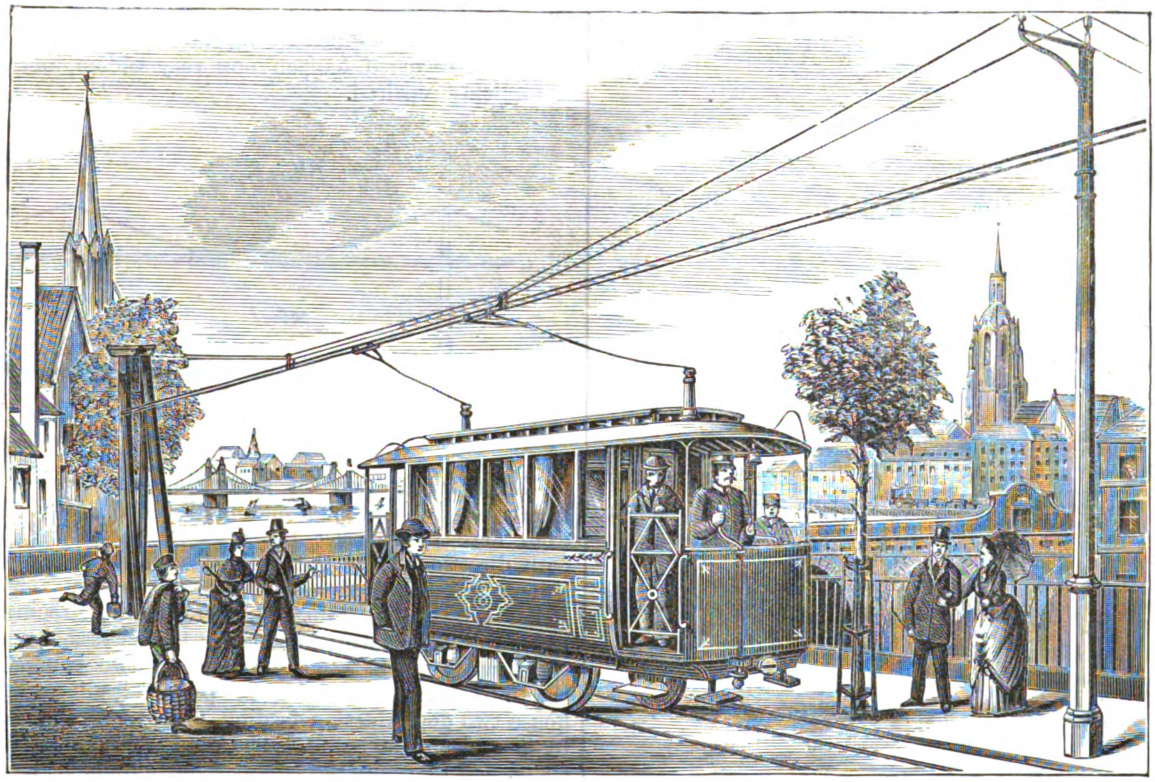

FIG. 1.
THE FRANKFURT-OFFENBACH ELECTRIC TRAMWAY—GENERAL VIEW.

The whole line is a single track line, but there have been arranged besides short double lines on both termini for shunting the carriages, and three passing places, distributed at nearly equal distances over the whole length, thus dividing the whole line into four sections. This makes it possible to increase the working capacity of the line and to have two trains going up and two trains going down the line at the same time. There have been at present fixed nineteen stopping places, as will be seen on the map. Many curves and gradients cause the working of this line to be difficult; the stiffest incline is 1 to 32 for almost 100 yards distance, another 1 to 45 for 150 yards, with a curve of 110ft. radius. The distance between the two rails is one metre.

The conductors have been arranged overhead in a manner similar to that shown at the Electrical Exhibition in Paris, 1881, by Messrs. Siemens Brothers, and at the Electric Railway, Moedling, Vienna, where slotted wrought-iron tubes are used for conveying the electric current along the line. The tubes are of 1in. internal diameter and $1\frac{1}{8}$in. external diameter, and

As already mentioned, there are three passing places in the ground line, and this necessitated the arranging of three passing places in the overhead conductors for the contact carriages of the two passing tramcars. This problem has been solved in an ingenious manner, and is shown in Fig. 6. The two parallel running slotted tubes R and S are gradually bent, and where they would meet a part has been cut out and replaced by a well-seasoned piece of hard wood. The two tubes are partly let into it, and the bores and slots are cut through the wood. On the other end of the wooden piece H the tubes G and I continue the conductors. Thus the four tubes are insulated one from the other, and the contact carriage can slide from tube R to I, or from G to S—in other words, can go up or down the line as the arrows point. To connect, now, the positive leads S and G, and the negative conductors R and I, two metal pieces *m* and *n* are arranged above the wooden block H insulated from each other (*see* Fig. 7 in section), and screwed to the corresponding tubes. The different wooden pieces are then screwed

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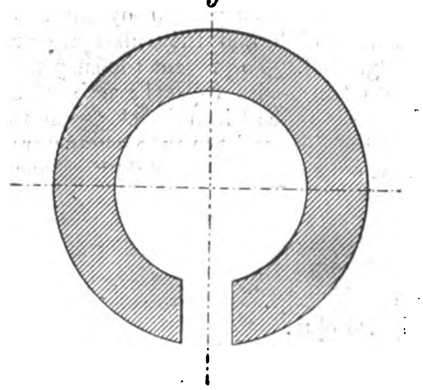
together with six bolts. To complete the passing place for the conductors the tubes L and K are joined to the tubes S and R, as shown in Fig. 6. When the contact carriage goes up or down the line it is necessary to direct it into the right tubes, which is effected by two movable tongues, *t* and *z*, pivoted at *p*, and shown in Fig. 8 in section. These tongues are always kept in the position shown in Fig. 6, which two

Fig. 3.



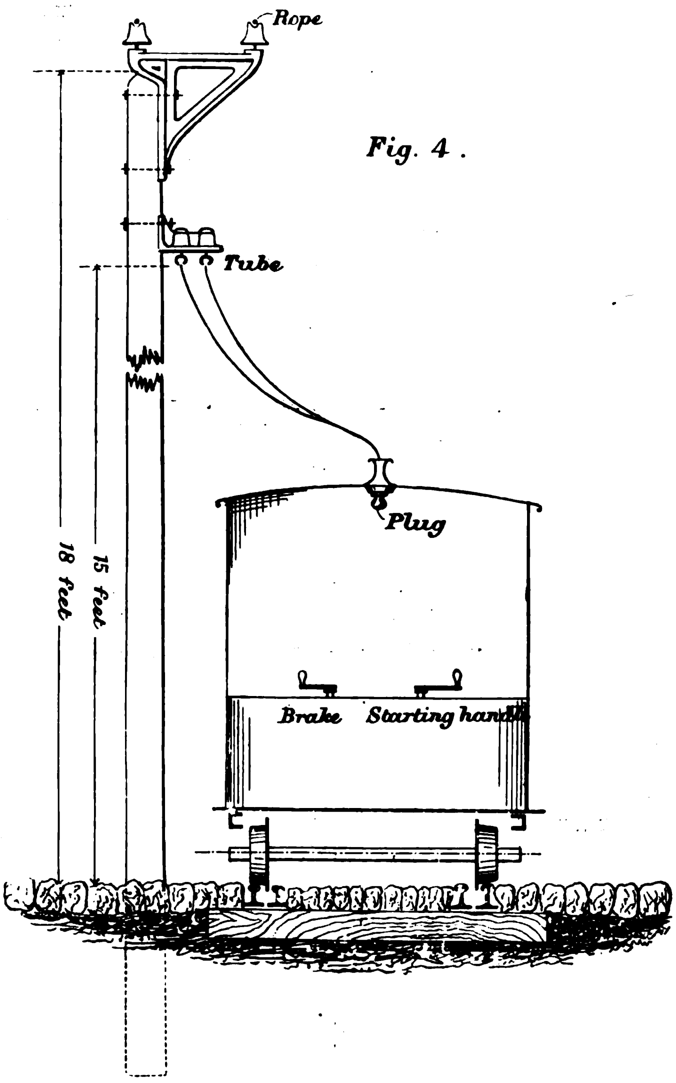
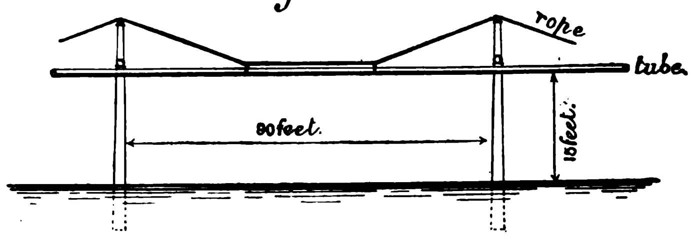


Fig. 4.

springs cause (*see* Fig. 9), acting on the upward bent end of the tongue. If a contact piece slides in R to the left, it will easily go into tube I—the tongue closes the way into K—and if a contact piston in G moves to the right, it will slide into tube S by pressing the tongue *t* aside.

This arrangement requires the contact carriage to be constructed in such a way that during passing through the wood heart piece H the flow of current to the tramcar is not interrupted, and also that it follows with perfect ease the curves of the conductors. Fig. 10 shows the tube conductor in longitudinal section and the contact carriage in elevation, Fig. 11 is a side elevation of it. Within the tube slide two cast-iron pistons C C, with pointed ends, and flat downwards projections, B, are cast on fitting into the slots of the tubes. These projections are riveted to a steel band, A, of ¾in. width and $\frac{1}{16}$in. thickness, which carries in the middle a bent brass piece, D, screwed to it. Besides the steel band connection two small copper wire ropes (not shown in Fig. 10) connect D to the right and left with the projections B and securing a safe passage for the current. The brass piece D contains also the insulated copper wire conductor E, which is fastened with slag to a rope, F, leading with the conductor E into the tramcar. On both ends of the steel band A are fastened two brass pieces carrying a steel rod, *d*, parallel to the tube conductor. Two metal pieces, *f*, screwed together slide on this rod, and carry between them a ring, to which the rope F is fastened. Rope F takes off the conducting wire rope E the strain caused by the moving of the tramcar. The two spiral springs on the rod *d* act as buffers when the pull is in one or the other direction. This arrangement, elastic in itself, has given great satisfaction during the four years' working of the line, and fractures of the rope F and copper wire E, which during the first few months' working frequently occurred, happen now very seldom, and are easily and quickly repaired.

Fig. 5.



The central station for generating the electric current has been erected about the middle of the line in Oberrad, and from here takes place the distribution of the current in both directions. In the boiler-house three large cylindrical boilers are provided with inclined fire-bars. The working steam pressure is 88lb. Under ordinary circumstances one boiler will be sufficient to generate the necessary steam, but at times, when much traffic takes place, two boilers are in use, the third is a spare one. In the passage leading to the engine-house two double-acting feeding pumps are put up, and close by is a deep water-well. The water contains a great deal of chalk, and therefore the boilers require frequent cleaning.

The engine house contains two separate large horizontal engines, both fitted with automatic expansion gear. The larger engine is a twin one, with modified Sulzer valve gear of 240 horse-power, but only one cylinder is at present used; the condensers which were for each cylinder provided have been removed on account of the scarcity of water. This engine has been built by Mr. R. Küchen, in Bielefeld, for the price of £1,400. The other engine, which has been lately erected, is a single-cylinder one of 120 horse-power, fitted with the well-known Collinann patent automatic valve gear, the cut-off being capable of being varied by the governor from *nil* to three-fourths of the stroke. Both engines are well suited for the heavy work, which consists of nearly eighteen hours' daily run, with only twenty minutes' stoppage during dinner time for lubricating purposes. Both automatic expansion gears have given great satisfaction, particularly when something wrong on the line happened. The diameter of the cylinder is 22in., by 37½in. stroke, and the speed is 75 revolutions per minute. The fly-wheel is 16ft. 6in. in diameter, and contains ten grooves for rope gear, but only six ropes 2in. in diameter are in use. Part of the exhaust steam is used for heating the feed water.

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THE FRANKFURT-OFFENBACH ELECTRIC TRAMWAY.

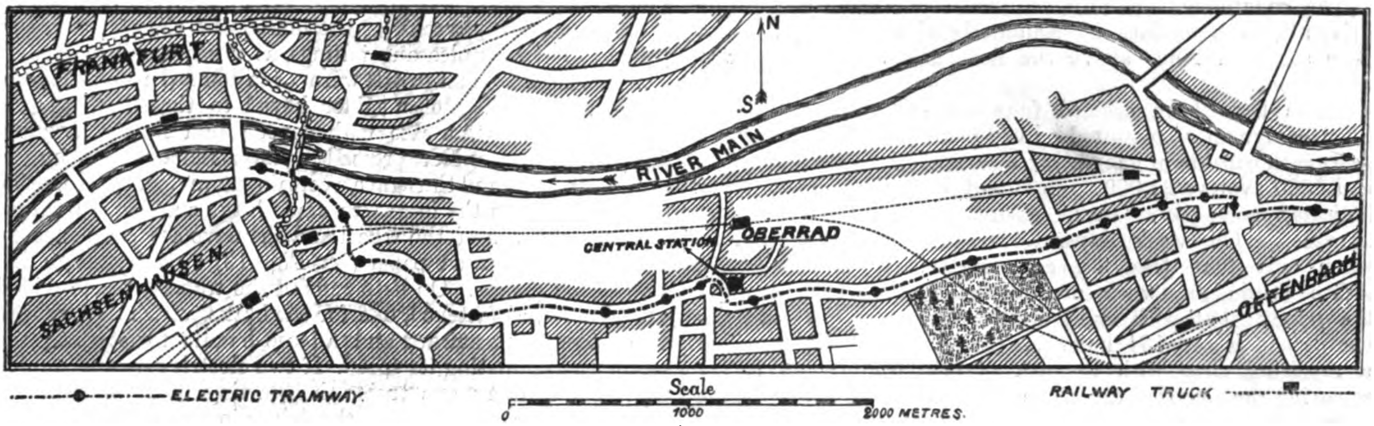


Fig. 2.

Fig. 7.

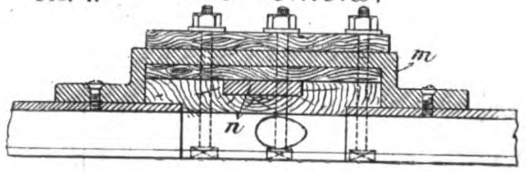
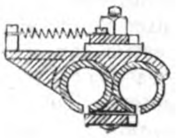


Fig. 9.



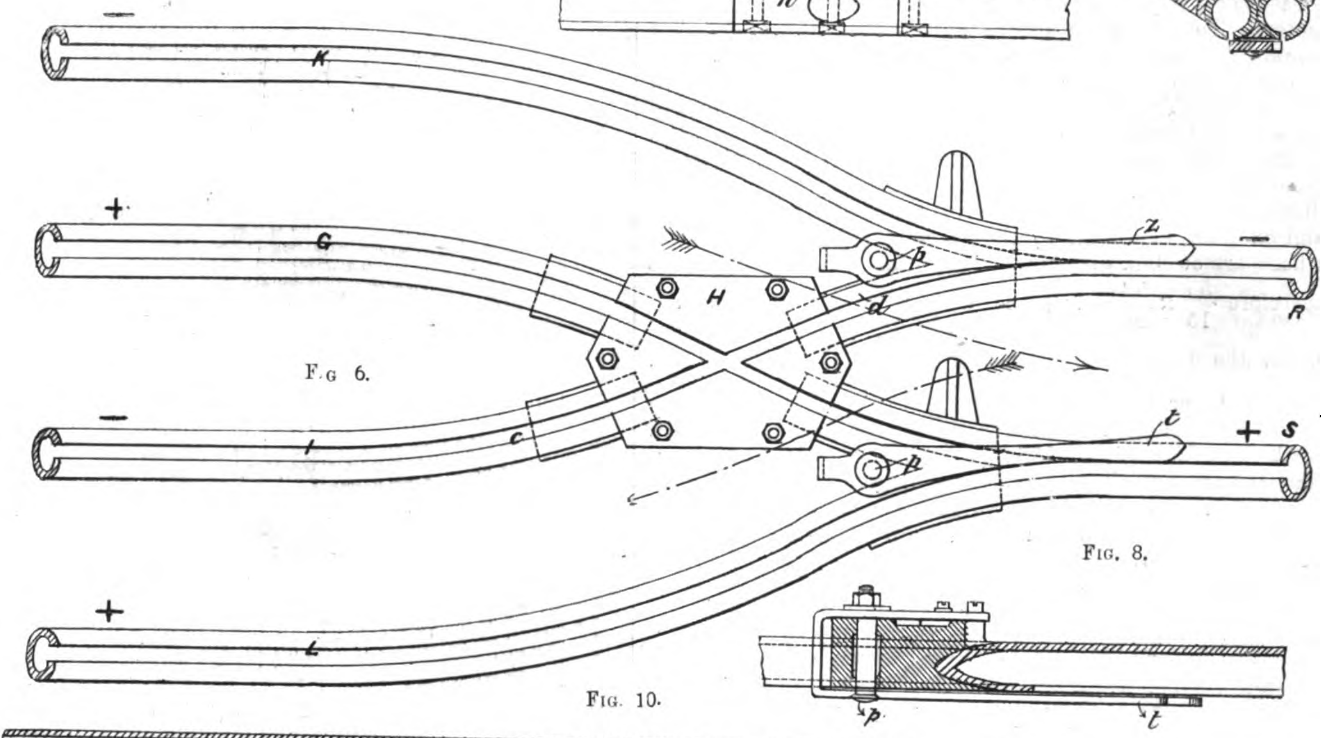
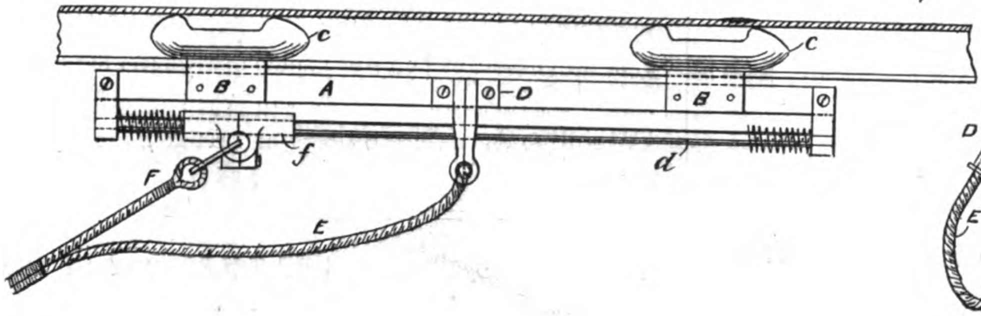


Fig 6.

Fig. 8.

Fig. 10.



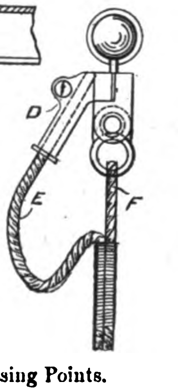


Fig. 11.

Figs. 6, 7, 8, 9, 10, 11.—Details of Overhead Conductors at Crossing Points.

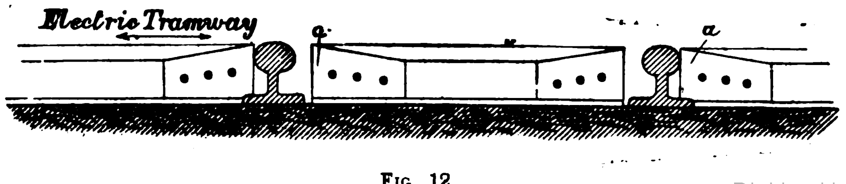


Fig. 12.

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The countershaft is provided with couplings, and can be driven by both engines independently of each other; it has been arranged 20in. above the floor and makes about 300 revolutions.

There have been erected four vertical compound-wound Siemens dynamos, mounted on bed-plates with belt tightening gear, each capable of generating a current of seventy amperes and 300 volts = 21,000 watts, and absorbing about forty indicated horse-power each. There is room for four more dynamos. On week days, under ordinary circumstances, when only four tramcars are running, two dynamos will suffice to do the work, one engine working with one-half the power; but with eight electric trains on the road the engines indicated 164 horse-power. There is also provided a repairing shop, with a track of rails leading into it for repairing the electric cars. The offices are above the engine room. In case of fire there are fixed on different parts of the central station three hydrants, which are worked by a Korting injector; steam in the boilers is kept up day and night.

The rolling stock of this electric railway consists of 10 electric cars and four ordinary tramcars; the former weigh about four tons, carry 36 passengers, and cost £500 each; the latter weigh about two tons, and carry 24 passengers. The electric car (*see* Fig. 1) is much stronger in its frame, which consists of channel iron, and carries under the floor the electric motor. The armature makes about 500 revolutions per minute, and has a diameter of 15in., and is about 19in. long.

The method of gearing in this case consists of two pairs of spur wheels. The pinion on the motor-shaft is of gunmetal, and has a pitch-diameter of 6in. and 15 teeth by a width of $2\frac{1}{2}$in. In this gears a steel wheel of 22in. diameter with 55 teeth, mounted on a countershaft, which also carries a pinion of 12in. diameter and 26 teeth. This drives a wheel of 24in. diameter and 52 teeth, keyed on to the tramcar axle. The tramcar wheels are of 30in. diameter. The total ratio in the speed is therefore $\frac{55}{15} \times \frac{52}{26} = 7{\cdot}3$, and with 500 revolutions of the motor the speed of the electric car will be $\frac{500}{7{\cdot}3} \times 7{\cdot}85 = 537$ft. per minute, or 6·1 mile per hour.

The traction force on tramways amounts, according to Mr. Reckenzaun's tests, to 25lb. per ton rolling load on a level line, and the horse-power necessary to propel a train consisting of an electric car and an ordinary car, both with full load, with a speed of six miles an hour on a gradient of 1 to 32, will be found as follows:—

1 electric car, dead weight	4 tons
1 ordinary car, dead weight	2 ,,
26 and 24 passengers, each 1·5cwt....	4·5 ,,
Total	10·5 tons

$$\text{H.-P.} = \frac{W.K.S}{33000} + \frac{W \cdot 2240 S}{33000} \sin \theta^*$$

$$\text{H.-P.} = \frac{10{\cdot}5 \times 25 \times 537}{33000} + \frac{10{\cdot}5 \times 2240 \times 537}{33000} \times \frac{1}{32}$$

$$\text{H.-P.} = 4{\cdot}2 + 11{\cdot}9 = 16{\cdot}1.$$

If there are four such trains on the line, and the total efficiency taken to 40 per cent., the horse-power required to work the line would be $(16{\cdot}1 \times 4)\ 1{\cdot}6 = 103$ horse-power.

There were several difficulties to overcome besides following the road in all its curves and gradients. For the electric tramway crosses once an ordinary horse-tramway and several times the State railways, which are built on the same level as the main road. The rails of the former were cut and provided with chilled iron crossings as usual, but the latter were not allowed by the State railway authorities to be channelled for the passage of the wheels of the electric tramcars. It was therefore necessary to arrange on these rails wedge-shaped steel pieces, *a* (*see* Fig. 12), allowing the flange of the car-wheel to climb over the State rails as smoothly as possible. This, besides assisting the wheels to leave the metals, had the great drawback that the steel tyres of the wheels were worn in comparatively short time, and it was always necessary to drive very slowly over these railway tracks, or the inmates of the cars were subjected to not very pleasant joltings, as visitors will remember.

The wheels at first used were of a somewhat elastic construction, consisting of a spider keyed to the shaft, and the tooth-wheel formed a case with cover round it, the four projections of the spider pressed against india-rubber buffers inside the case, and thus gave a certain amount of dead motion to the gear, with the intent to smooth the starting. But now the cast steel rim of the wheel and the nave are connected by a disc of compressed paper (*see* Fig. 13), which design has given good results. On both ends of the tramcar are provided two handles, as fastened, one for the brake, which is arranged as on ordinary tramcars, and a loose handle for starting the motor and regulating its speed. If two electric cars are coupled together, forming one train, the starting gear on both are mechanically connected, and the driver in the first car has perfect control over both motors. The brakes on both cars are now also mechanically connected, and one driver works it as easily as possible. The cables for conveying the current enter the car through two tubes fastened on the roof of the car (*see* Fig. 4), and are brought under the floor to the brushes of the motor. Plugs are arranged in the roof above the driver's head, the drawing of which, in cases of emergency, interrupts the circuit, and consequently stops the motors.

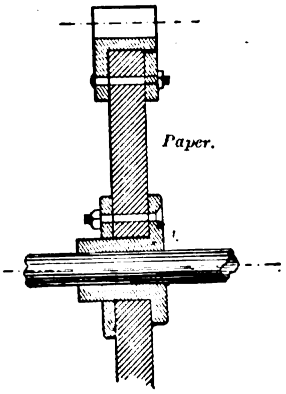

Fig. 13.

The Working.—The overhead conductors show scarcely any sign of wear, which may be due to the frequent cleaning and greasing of the tubes; the cast-iron pistons sliding in them last from five to six weeks, when they have to be renewed, the cost of which is very small. To the most wear and tear are exposed the wheels. The metal pinion wears out in about six weeks; wheels with helical teeth have given better results. Much more trouble has given heavy snow in the winter to this exposed line, and occasionally interrupted the traffic during a few hours. The trains run every twenty minutes from 6 a.m. till 11 p.m., and over one million passengers have been conveyed on this line during last year. On the whole the working of this line has been very satisfactory, and has given great credit to the makers, Siemens and Halske, who supplied the electrical plant.

THE RISE AND PROGRESS OF TELEPHONY IN THE UNITED KINGDOM.

(Continued from page 438.)

One of the chief difficulties which has been experienced by the telephone companies in extending their systems of exchange and private wires has been in obtaining way-leaves for their wires. The difficulty has chiefly arisen in the case of individual proprietors, and the local authorities have usually been ready to meet the companies in a reasonable spirit. In the case of the Wandsworth Board of Works, the United Telephone Company was refused permission to carry its wires across certain streets; but it was decided on appeal that the

* Vide *The Electrician*, January 6th, 1888, page 209.

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Local Authority had no right to enforce such a prohibition, provided the wire did not interfere with the use of the street, was not a source of danger, and was not attached to supports placed in the street. The refusal, however, of some large London property owners to allow wires to be attached to their property has not only in many cases caused great expense to the companies by compelling them to carry their wires by circuitous routes, but in some instances it has shut out considerable districts from the advantages of telephonic communication.

In 1884 and 1885 Bills were promoted in Parliament by the United Telephone Company with the object of acquiring compulsory powers, where necessary, and of obtaining way-leaves, but they were both withdrawn, and need not be further noticed, as a Bill of similar character has been presented to the House of Commons during the present session, and we shall presently consider its more important provisions.

In March, 1885, a Select Committee of the House of Commons was appointed to consider the law relating to the control over telephone, telegraph, and other wires. A large number of witnesses were examined by the committee, including independent experts, the engineer of the United Telephone Company and other representatives of the companies, together with representatives of the vestries and of the "aggrieved householder."

The experts were almost unanimously of opinion that it was essential to the development of telephonic communication that overhead wires should be allowed, as the expense of carrying them all underground would make it necessary for the companies to charge prohibitive rents for the use of wires. It was also suggested that far more numerous and more serious accidents would probably occur during the process of breaking up the streets for the purpose of laying underground wires and for carrying out repairs, than the few trivial ones which had been caused by the breaking of the overhead wires.

As the result of the examination of the witnesses the committee drew up a report in May, in which they expressed the opinion that the risk of danger from overhead wires had been greatly exaggerated; but they stated that they considered there ought to be some change in the law relating to control over wires, with a view to their better supervision.

As the law then stood the Postmaster-General could lay wires, subject to certain notices and regulations, underground along country roads, without obtaining the consent of the road authority; but this had to be applied for in towns, with an ultimate appeal to the Railway Commissioners in case of refusal. For overhead wires, whether in town or country, permission had to be obtained, subject as before to appeal, and the permission was subject to various conditions, including a provision that a post must not be placed within ten yards of a dwelling house without the consent of the occupier. In the country there were various conditions with regard to permission of owners, with the right of appeal in case of refusal, and the publication of notices, which often involved considerable delay.

No power was given to the Postmaster-General to make attachments to private property without the consent of the owners, but in towns, with the permission of the road authority, he could carry wires over buildings, or lands other than building land or gardens, subject to certain restrictions.

The companies had no statutory powers, being merely licensees of the Postmaster-General, and they were therefore not able to carry wires over private property except with the consent of the owners. Certain corporations had also certain recently-conferred powers giving them authority to deal with wires.

Having regard to the state of the law the committee, having strongly expressed their opinion that no course should be adopted which would materially hamper the extension of the telephonic system, the free development and use of which they considered of essential importance to the public convenience, suggested that in order to obviate the difficulties and delays experienced by the Post Office in laying down wires, the Postmaster-General should be authorised to give notice of his intention of laying down a line of wire before instead of after obtaining the consent of the road authority, and that any objections should be referred to some competent tribunal.

The Postmaster-General they considered should also be allowed to make attachments to private property with the consent of the occupier only, without having, as heretofore, to obtain permission also from the lessee and the owner; but such consent on the part of an occupier should only hold good during the term of his occupation.

With regard to the telephone companies the committee considered that they should have the same power of running wires as was recommended for the Postmaster-General, provided that their wires did not interfere with those required for the public telegraphic service by the Postmaster-General. They should also be allowed under proper regulations to carry their wires over private property without the owners or occupiers having the right of prohibition, but they should be required to remove them for any good cause shown, and should be responsible for any damage caused by them.

With regard to attachment, the committee considered that when it could be shown to the satisfaction of the local authority that certain individuals or districts were debarred from the use of the telephone, as was the case with the Inner Temple and Covent Garden, on account of the refusal of way-leaves, compulsory powers should be given to the companies subject to the payment of reasonable compensation.

They proposed that bye-laws for the regulation of wires should be made for London by the Metropolitan Board of Works, for provincial towns by the Corporation, and for rural districts by the Local Authority, subject in each case to the sanction of the Board of Trade, and that in London the enforcement of the bye-laws should be entrusted to the City Corporation and to the Vestries and District Boards. Arrangements should be made for the identification of wires, by registration or otherwise, and all ownerless wires should be removed.

The United Telephone Company's Bill now before Parliament practically embodies these recommendations of the Committee with respect to the telephone companies. A clause is inserted enacting that wires shall not be carried over Crown lands or public buildings without permission from the proper authorities.

(To be continued.)

A CENTRAL ELECTRIC LIGHTING STATION AT AMSTERDAM.

(FROM A CORRESPONDENT IN HOLLAND.)

A central electric lighting station is in process of construction at Amsterdam. Some time ago a company was formed in this city, with a capital of 600,000 guilders, for the purpose of supplying electric light to the shops on the Kalverstraat and the Vorburgwal from a central station. After consultation with some thoroughly competent engineers, it has been decided to adopt an arrangement which has not hitherto been applied to central stations. On account of the relatively short distances the employment of alternate-current machines and transformers has been abandoned, and the work will be done by continuous-current machines. The combination of high-speed engines and small dynamos, as well as the use of resistance-regulators, for maintaining the tension constant, as is customary in all central stations in Germany (at Berlin, Lubeck, and Elberfeld), has been set aside as technically deficient. It has been decided to put up but two very large slow-speed dynamos with automatic potential regulation.

It is intended to use two compound condensing steam engines of 240 horse-power each, running at 100 revolutions per minute. Upon the axle of each engine the dynamo which is combined with the fly-wheel is mounted. The dynamo therefore also makes but 100 revolutions per minute, and feeds, when normally loaded, 2,400 incandescent lamps of sixteen candles. The machine will, however, be capable of taking a maximum load of 4,000 lamps. Accordingly the normal output of 250 horse-power as stated above is to be understood with the steam engine working under the most favourable steam supply. By increasing the supply the output can be raised to 400 horse-power.

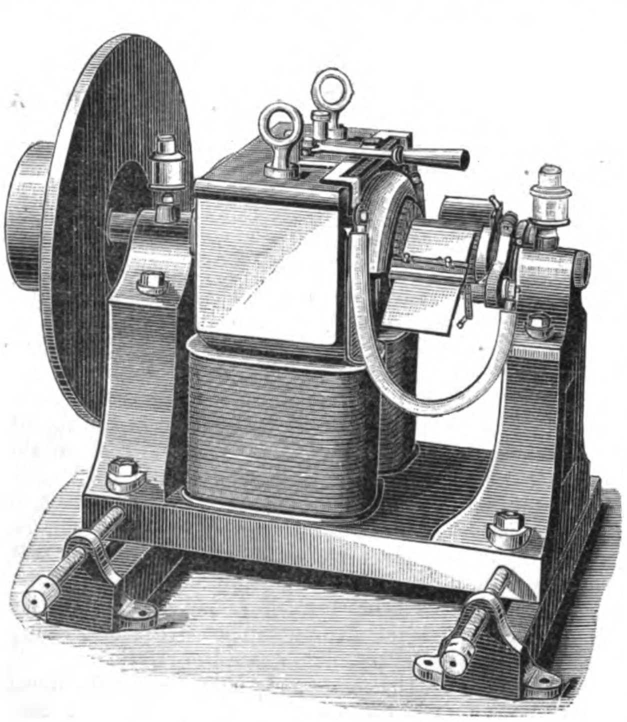
Both machines will work upon one line of conductors. The engaging and disengaging of each machine is done by simply moving a lever

Considering that with this arrangement all intermediate factors as belts, counter-shafting, &c., are done away with, and that the speed is only 100 revolutions, it appears that the security of working will surpass anything hitherto existing, the more so as the machines are but moderately loaded. But if necessity should arise either of the machines can at once be put out of gear, as each of them is capable of doing the whole work. Apart from the highly interesting general arrangement, it appears that the question of ample reserve has also been fully solved in this instance. The main conductors are so large that the maximum current will not involve a greater loss of tension than 5 volts.

The leading idea in planning this station has been not only to adopt the technically best arrangement, but also to simplify the working as much as possible, and to make it economically cheap. By avoiding the numerous small machines, by reducing the number of revolutions, by doing away with all regulators of resistance, it is hoped to be able to reduce the service to four or five men; whilst, for instance, the central stations put up at Berlin for the same output require not less than twenty men in the Markgrafenstrasse, and fifteen in the Manerstrasse. It would appear from this, as well as from the fact of the more economical working of slow-speed compound steam-engines, that a considerable higher rate of profit may reasonably be expected. The execution of the whole installation was entrusted to the Helios Company, at Ehrenfeld and Cologne, who alone have hitherto built large slow-speed dynamos for continuous currents. The machines were designed by Mr. H. Coerher, the manager of the Helios Company.

MESSRS. FOWLER, LANCASTER AND CO.'S DYNAMOS.

We illustrate herewith a dynamo of the Kapp type, constructed by Messrs. Fowler, Lancaster and Co., of Birmingham.



THE FOWLER-LANCASTER DYNAMO.

Our illustration is taken from a photograph of a 3-unit machine, intended to run at 1,000 revolutions per minute, and giving 63 volts with 53 amperes. The field-magnets and pole-pieces are forged in one piece of best Swedish iron, planed and shaped. The pole-pieces are polished and varnished. The commutator is phosphor bronze, and has 48 sections, with 4 turns of wire in one layer connected to each section. The armature is of the ring type, its core is built up of charcoal iron discs, No. 22 wire gauge thickness. The diameter is 8¼in., and resistance ·058 ohms, the resistance of the field being 18 ohms. The brushes are made of strip copper, the inside strips being slit, but not those outside. The machine runs quite cool, and without sparking at the brushes. Altogether the machine seems to be a very good specimen of modern dynamo practice.

ON THE CHANGES PRODUCED BY MAGNETISATION IN THE DIMENSIONS OF RINGS AND RODS OF IRON AND OF SOME OTHER METALS.*

BY SHELFORD BIDWELL, M.A., F.R.S.

In a paper communicated to the Royal Society in 1885,† the author has shown that the elongation which an iron rod undergoes when magnetised does not, as had been generally believed, remain unchanged at a maximum when the magnetising force exceeds that which is sufficient to produce so-called saturation. On the contrary, he finds that when the magnetising force is continually increased beyond this limit the elongation becomes gradually less and less until the rod, after first returning to its original length, ultimately becomes actually *shorter* than when in the unmagnetised condition.

The experiments described in that paper are, however, open to objection on the following grounds:—(1) The field due to the magnetising solenoid was not quite uniform; (2) the effect of the ends of the rods was uncertain, and might have played some material part in the production of the phenomena in question; (3) all the rods used in the experiments retained a certain amount of permanent magnetism; (4) the experiments might with advantage have been carried further. The paper now offered to the society contains an account of some new experiments which were designed to meet the above objections.

Objections (1) and (2) were met by using rings instead of rods of iron, observations being made of the changes which occurred in their diameters under the influence of various magnetising forces obtained by passing currents of electricity through coils of wire encircling the rings. To remove the third objection the rings were demagnetised before every observation, by a modification of the method described by Prof. Ewing in the *Phil. Trans.*, Vol. CLXXVI., p. 537. And lastly, the battery employed was increased from seven Grove cells to thirty.

After an explanation of the precautions taken to guard against the effect of current heating, an account is given of some experiments with three rings arranged in slightly different ways, and the results are compared with those of an experiment made under similar conditions with a straight rod. It was found that in their general character the phenomena of elongation and retraction were just the same in both cases, and were in close agreement with those of the former paper. The differences in mere details were not greater than would probably be found to occur in different specimens of iron of the same form.

Being satisfied that these curious effects of magnetism were practically independent of the form of the iron, and having regard to the fact that it is much easier to obtain intense fields with straight than with circular solenoids, the author thought it worth while to make some further experiments with straight rods. The metals used in addition to iron were cobalt, nickel, manganese steel, and bismuth; and the highest magnetising force reached about 840 C.G.S. units, the maximum in the old experiments having been 290.

It was found that the retraction of the iron continued to increase with higher forces until it was finally as much as 45 ten-millionths of the length of the rod, when there were indications that a limit was being approached. The attraction of the nickel reached 113 ten-millionths, when it also was evidently not far from its limit.

The behaviour of the cobalt rod was exceedingly curious

* Abstract of paper presented to the Royal Society, Feb. 9, 1888.
† "Roy. Soc. Proc.," Vol. XL., 1886 (No. 242, p. 109).

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and interesting. No evidence of any change of length appeared until the magnetising force exceeded 30 or 40 units. Then the length of the rod began to diminish, and continued diminishing until the force was about 400, when the retraction amounted to 50 ten-millionths. But beyond this point the rod gradually became longer again, and the retraction with the highest force of 800 units was only three fifths of its maximum amount. It was ascertained that the maximum retraction did not coincide with a maximum of magnetisation, as might have been suspected to be the case. It is suggested that iron and nickel might possibly behave in a similar manner under sufficiently high magnetising forces.*

Tables and curves are given showing the relation between magnetising force and changes of length in each metal.

Bismuth was found to be slightly elongated in strong fields, though no change could be detected with forces of less than about 500. The greatest elongation observed was about 1·5 ten-millionths of length. Manganese steel was almost unaffected. The elongation in a field of 850 was estimated to be about one fifty-millionth of the length.

Finally, it is shown that the mechanical stress produced in iron by magnetism does not account for more than one-fifth part of the observed magnetic retraction.

An appendix to the paper contains evidence of the high degree of accuracy obtainable by the method of observation employed. In the very great majority of the measurements of elongation and retraction, the probable error was less than one two and a-half millionth part of an inch, or one hundred-thousandth of a millimetre; and the results of experiments made upon different days (the apparatus having been in the meantime dismantled), or with currents of ascending and of descending strength, were strikingly concordant. This degree of precision is attributed to the perfection of the optical arrangements, which rendered it possible to project the image of a wire with such sharpness that after reflection from a mirror its position upan a scale 24ft. (732cm.) distant could be read to a quarter of a scale division, each whole division being equal to $\frac{1}{40}$in. (0·64 mm.). The magnifying power was such that a change of one two and a-half millionth part of an inch (or one hundred-thousandth of a millimetre) in the length of the rod under examination caused the image of the wire to move through about three-quarters of a scale division. More accurately, a scale division corresponds to 0·000018 mm.

The currents used were measured by one of Ayrton and Perry's commutator ammeters, and the accuracy with which the magnetising forces were estimated, though quite sufficient for the purpose of the experiments, does not claim to be very high.

COVERED WIRES: A NEW PROCESS OF INSULATION.

We learn from the *Centr. Blatt. für Elektr.* that MM. Weber and Schefbauer have succeeded in preparing insulated conductors by a new process, for which important advantages are claimed. The method is said to be particularly applicable to the manufacture of double or multiple wire cables of flat section, and it effectually prevents any change of relative position in the wires. Each wire is first wrapped in several layers of *paper*; it is then passed through a bath of ammoniacal oxide of copper, by which the superficial layers of the paper are converted into cellulose. In this stage the wires of the cable are laid together in position, and are then passed through a rolling mill; the cellulose layers are thus pressed into cohesion, and the whole forms one solid mass. By a mechanical device the wires are retained exactly in their true positions while passing under the rollers. The cable now again enters a bath (which performs some function not fully made known), and it is afterwards rolled a second time between hot rollers. The rollers are heated by steam, and apply a very powerful pressure. The object of the second rolling is chiefly to get rid of moisture. The cable is next passed into a bath of linseed oil at a boiling temperature, which thoroughly saturates the covering. Lastly, it passes once more through hot rollers to get rid of the excess of oil. The finished cable is very supple, and is proof against damage from moisture or from ordinary variations of temperature. Its durable qualities remain to be discovered.

* It is also suggested that some specimens of cobalt and nickel might, like iron, begin with a small preliminary elongation, thus accounting for Prof. Barrett's observation that cobalt undergoes elongation when magnetised (*Nature*, Vol. XXVI., p. 585).

BOOKS RECEIVED.

"Traité Élèmentaire d'Électricité, avec les Principales Applications." By Capt. R. Colson. 2nd Edition. (Paris: Gauthier-Villars. 1888.)

"Sur l'Emploi de l'Électricité pour la Transmission du Travail a Distance." By Capt. J. Boulanger. (Paris: Gauthier-Villars. 1887.)

"Introduction a l'étude de l'Électricité Statique." By M. E. Bichat and M. R. Blondlot. (Paris: Gauthier-Villars. 1885.)

"Construction des Étalons Prototypes de Resistance Électrique du Ministère des Postes et des Telegraphs." By M. J.-René Benoit. (Paris: Gauthier-Villars. 1885.)

"Determination des Éléments Magnétiques en France." With new Magnetic Charts, corrected up to January, 1885. By M. Th. Moureaux. (Paris: Gauthier-Villars. 1886.)

"Sur les Progres de la Science Électrique et les Nouvelles Machines d'Induction." By Capt. J. Boulanger. (Paris: Gauthier-Villars. 1885.)

"A Practical Decimal System for Great Britain and her Colonies." By R. T. Rhode. (London: Effingham Wilson.)

"Proceedings" of the Royal Society of Edinburgh, No. 124.

MEETINGS OF SCIENTIFIC SOCIETIES.

TO-NIGHT (FRIDAY), March 23rd.

Institution of Civil Engineers.

7.30 p.m. Students' Meeting. Paper, "Principal Types of American Swing Bridges." By Mr. H. W. Hodge, Stud.Inst.C.E.

Royal Institution.

9 p.m. Lecture by Sir Frederick Bramwell.

Physical Society of Glasgow University.

Paper, "The Scientific Work of Roger Bacon." By Mr. J. Strachan, M.A.

SATURDAY, March 24th.

Royal Institution.

3 p.m. Lecture, "The Modern Drama: (3) English." By Mr. Wm. Archer.

MONDAY, March 26th.

Society of Arts.

8 p.m. Cantor Lecture IV., "Alloys" (3). By Prof. W. Chandler Roberts-Austen, F.R.S.

TUESDAY, March 27th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Paper to be further discussed, "Economy-Trials of a Non-Condensing Steam-Engine —Simple, Compound, and Triple." By Mr. P. W. Willans, M.Inst.C.E. Paper to be read, time permitting, "Compressed Oil-Gas and its Applications." By Mr. Arthur Ayres, M.Inst.C.E.

Royal Victoria Hall (Waterloo Bridge-road, S.E.).

8 p.m. Lecture, "The Great Ice Age." By Mr. Litton Forbes.

Society of Arts.

8 p.m. Foreign and Colonial Section. "The Panama Canal." By Mr. J. Stephen Jeans.

WEDNESDAY, March 28th.

Chemical Society.

8 p.m. Annual General Meeting for Election of Officers.

Civil and Mechanical Engineers' Society.

7 p.m. Meeting at the Town Hall, Westminster. Paper, "The Development of Machinery in relation to Hand Labour." By Mr. Ambrose A. Myall, A.M.I.C.E.

*** Particulars of meetings to be held or papers to be read before Scientific Societies during the ensuing week should reach us not later than Wednesday, 6 p.m.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The directors of this company announce the payment of an interim dividend of 2s. per share, free of income-tax, being at the rate of 2 per cent. per annum, for the quarter ending 31st March, 1888. The dividend will be payable on and after the 24th April next.

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GOOD FRIDAY NOTICE.

Next Week "THE ELECTRICIAN" will be published on THURSDAY morning. Advertisements should reach the Publisher not later than 4 o'clock on WEDNESDAY.

ANSWER TO CORRESPONDENT.

IGNORAMUS (London).—*It would certainly be possible to measure resistance with more or less approximate accuracy in the way which you propose. But, as you say, the tests would have to be made with a current of constant strength; and, if you consider further, you will probably see that the means by which you hope to secure this will be upset by the insertion of the wire as a shunt. The principal objection, would, however, arise from the fact that it is a non zero method. You are probably aware that far greater accuracy is attainable by balancing a galvanometer needle at zero than by taking deflection reading. In this respect the use of a Wheatstone bridge, or even of a differential galvanometer, is very much better than any such method as you propose.*

OUR ELECTRICAL DEFENCES.

The Report of the Committee on the Fortification of our Ports has drawn attention afresh to the unsatisfactory condition of these defences and to the measures necessary for their improvement. As regards the latter, Mr. STANHOPE'S statement in the House of Commons on the Naval and Military Estimates for the year encouraged the hope that something would be done at once for the existing forts, and something possibly in the future for the mercantile ports. The further protection of the naval dockyards and shipping lying behind such forts as Portsmouth and Plymouth being an admitted necessity will no doubt be taken in hand without delay; but we cannot feel the same assurance in respect to the merchant shipping ports, which at present are practically defenceless, and which are to be left to the joint action of the local authorities and the Government. The cheers which greeted the Secretary's announcement that he wanted to induce the localities "to come forward and co-operate with the Government for their own defence" were perhaps not of good omen for the suggestion, betraying, it may be feared, more satisfaction with its economy than anxiety for its success. Volunteer defence is no new thing in the history of this country; but the initiative has hitherto been taken under strong public impulse, and if the mercantile shipping ports have not yet proffered to defend or pay part of the cost of defending them it is probably because they are regarded as a national concern, and not merely as a local one. Nevertheless, some attempts have been made for the establishment of volunteer submarine mining corps, and it may be hoped that the

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Government will approach these bodies with liberal terms, while, on the other hand, the local authorities should respond with that public spirit which has always characterised the voluntary effort where national safety is in question. Mr. STANHOPE tells us that no time should be lost: and without being alarmists we may take it that he has reasons for making an urgent appeal to the patriotism of the nation.

This being the case, the present seems an opportune occasion for dwelling on the part which electricity will play in these defensive measures. In one branch alone, that of submarine mining and torpedo operations, some articles recently published in these pages sufficiently indicate the importance of these implements of warfare and the ingenuity bestowed on their construction. There is a wide field still open for inventiveness in these appliances; and no nation stands so much in need of them as ourselves. As to the efficiency of submarine defences, even at their best there is a wide diversity of opinion, the late HOBART Pasha, for example, contemptuously thrusting aside all the torpedoes an enemy could bring against him. But Admiral HOBART was an Englishman, and whatever may be said against it we observe that foreign nations do not despise the torpedo, and count upon it largely for their own defence. Lieut.-Colonel BUCKNILL writing on this subject in our contemporary *Engineering* last July showed that during the American war of secession between December, 1862, and June, 1865, enormous damage was inflicted on the Federal navy and transport ships by Confederate submarine mines, although for a considerable time the Confederates possessed no special stores, no trained *personnel*, and but little scientific knowledge of the subject. As many as thirty-seven successful operations of this kind are recorded, the result of which was the destruction, partial or complete, of a like number of armour clads, monitors, gunboats, torpedo boats, or transports. Since the American war vast improvements have been made in these engines of destruction, most of which, we need hardly say, now depend more or less on electricity for their effective manipulation or automatic mechanism. The importance of this fact, it is gratifying to notice, has not been entirely overlooked by the naval authorities, whose school on H.M.S. "Vernon" is actively training specially selected men in those branches of scientific knowledge on which the success of torpedo and submarine mining warfare so closely depends. A similar school for the Royal Engineers has long been in operation at Chatham with such well-known advantage to the land forces that we need not further refer to it here.

The extension and organisation of Submarine Mine Volunteer Corps at all the important seaport towns of the kingdom will tax the resources of these schools to the utmost. The local volunteers cannot be expected to come to Chatham or to Portsmouth to be instructed in the use of the weapons placed at their disposal, and it follows that instructors will have to be—or ought to be—told off to the distant places to impart the necessary knowledge. It is no doubt the boast of every invention connected with mining warfare that non-skilled persons can be safely trusted to operate it. But if we took the inventor at his word there would be no need for naval or military mining schools; and we dwell on the importance of special training in this relation because, in view of the possible, and we hope probable, requirements of the mercantile ports, the supply of competent instructors may, we fear, fall short of the demand. From the navy, at all events, there is reason to apprehend that the amount of training has not exceeded, if, indeed, it has satisfied, the immediate needs of the service; and it is by no means certain that the Royal Engineering Corps could undertake the duties we are now discussing, which pertain more to the navy than to the army. Some unusual efforts have latterly been directed in both branches of the service to the diffusion of electrical knowledge. We hope and trust that account will be taken of the increasing demand for it by the auxiliary forces, who will naturally expect to get what they require through the instrumentality of the Admiralty or the War Office. Commenting on the condition of affairs disclosed by the Committee's report the *Standard* pronounces it both disgraceful and incredible that the wealthiest nation in the world is in such a defenceless plight because in time of peace it is too careless or too niggardly to provide what is wanted. These grave charges are, indeed, well deserved if the authorities decline to increase the number of naval and military technical schools, or, at least, to enlarge the capacities of the existing establishments.

We write on these points, however, not in confident expectation of being listened to. There are other matters which have long been discussed and recommended in connection with our coast defences, but which have received no attention. A recent issue of the *Liverpool Journal of Commerce* has revived a subject which long ago was warmly advocated in these pages—namely, the connection of our coastguard stations by electric telegraph. As a matter of fact, these stations are as isolated and as out of touch with the defensive forces of the land as if there were no land to defend, but only a Custom House office. The inconvenience of this isolation is felt by our shipping every day; but its danger in time of war was proved during the Jubilee Naval manœuvres, when the coastguard outlooks were impotent to render any service, because they had no telegraphic connection with the adjacent land lines. In one or two instances a connection was established, but with the aid of the Royal Engineers specially lent for the occasion. This incident, although creditable to the soldiers concerned, illustrates the helplessness to which our sailors are reduced by their enforced ignorance of telegraphy. Many exaggerated things are said about the unpreparedness of our navy, but we are guilty of no exaggeration when we say that at the present moment our first line of defence is utterly destitute of any knowledge, theoretical or practical, of electric telegraphy. Royal Engineers cannot always be had to order, and there is we believe no vessel in the navy that could land a party of men on this or any other coast capable of erecting a temporary telegraph wire, or of working it if erected for them. Excellent signalmen the navy possesses, and the Morse code is largely employed by them; it only needs to be applied to the manipulation of the Morse telegraph instrument to become available on emergencies such as have occurred already, and may occur again at any moment. The operations of submarine and military mining are closely associated with those of electric telegraphy; the laws which govern the one are applicable to the other, and it seems to us that in the navy it should be the rule, as happily it is in the army, to combine both subjects in the same course of instruction. To some extent these observations apply also to the auxiliary forces at mercantile ports, in the training of whom the value of electric telegraphy should not be overlooked.

Mr. W. S. Gilbert on the Electric Light for Theatres.— Replying to a representative of the *Pall Mall Gazette*, Mr. Gilbert is reported to have said:—

"If I were asked for my opinion, I should strongly recommend that the adoption of the electric light in theatres should be made compulsory by Act of Parliament. It always seems ridiculous to me that while the outcry about exits is chronic, no one thinks of striking at the root of the evil, which is the use of gas behind the stage, where all the materials are of the most inflammable nature. Very little danger can come of using gas in the auditorium, whereas, on the stage, it is a never-ending source of danger."

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A PROPOSED NEW PUBLIC TELEPHONE SYSTEM FOR CITIES AND LARGE TOWNS.

BY WALKER MOSELEY.

(Continued from page 373.)

The method described for leading and joining up the metal tubed wires does not necessarily call for any change in either the method or the material employed for their insulation and sheathing, as the ordinary lead-covered wires would answer almost perfectly; but if the main objects can be attained by less bulky and less expansive coverings, the practical adoption of the plan I have so far described will be greatly facilitated. The lead-covered insulated wires at present in use are almost invariably insulated with gutta percha, for india-rubber, yielding more easily to pressure, would allow the central wire to be pressed out of the centre in some places, and thus spoil the average value of the insulation. A review of the considerations which have placed gutta percha and india-rubber in the highest rank as insulating materials for wire will show that an outside covering of metal entirely alters the relative merits of the insulating materials. Gutta percha is best under water or underground if constantly damp, but in places exposed to alternations of dry air and dampness, pure india-rubber is superior to all other insulators. Other materials, however good in their insulating qualities when fresh, become porous or rotten in two or three years if exposed to dry air. As for the most modern nostrum, "Kerite" or paraffin wax, it is untrustworthy whether new or old, for reasons well known to practical men. But if good permanent insulation is determined upon, it is now by common consent agreed that lead-covered wire ensures permanent insulation, and that for important purposes the extra cost is hardly worth consideration. But once arrived at that conclusion it naturally follows that if the metal sheathing protects the enclosed material from the action of dry air, it may be found that some of the less homogeneous or tenacious materials will prove very economical substitutes. Three necessary qualities must be combined before such a substitute can be safely adopted, viz.: 1st. Insulating properties equal to india-rubber or gutta percha. 2nd. Sufficient rigidity of substance when surrounding the wire to prevent the wire getting out of centre when being covered with the metal sheathing, and also to prevent creasing when the metal-covered wire is bent. 3rd. Sufficient elasticity to prevent crumbling under the act of such bending. I am not aware of any material that fulfils these conditions so well as hair, such as commonly passes under the name of horsehair.

Horsehair yarn tightly wound round the wire, and steeped in melted resin tempered with a small amount of boiled oil, furnishes a better insulation than either india-rubber or gutta percha, and for permanence it is well known that the materials, either separately or in combination, are practically imperishable under exposure to all weathers. I would not say such insulation would in all cases be trustworthy after rough handling and bending, but with the protection of a metal sheathing it would clearly withstand all the evil elements to which insulated wires are exposed. No insulated wires will stand rough handling without injury, and if metal-sheathed wires show the effects of rough handling more plainly than those without, there is so much better guarantee—under proper oversight—that the fixing of the wires is done with due care. The adoption of resined horsehair insulation opens up a further question, viz., whether lead covering cannot be improved upon? The usual process of lead covering is by passing the insulated wire through a large tube, and the latter is diminished as it passes through small dies until the last one closes the tube tight on the gutta-percha covering. To effect this by the direct process would cause the melted metal to soften the gutta percha and thereby allow the wire to run out of the centre, which would, in consequence, lessen the value of the insulation. The use of horsehair involves no risk of this kind, as the molten metal does not alter the hair, either to lessen its strength or elasticity. But the demand for a complete metallic circuit, for most purposes except public telegraphy, has at length become pronounced, and the question arises, why not use the outside metal covering for the return? The answer is, the covering must be reduced in weight and bulk or it would be impracticable to insulate it well enough to make it other than a mere earth return. The metal must also be a better conductor than tin or lead, as well as stronger. A copper sheathing supplies these desiderata, and it is effected as follows: Three thin, narrow copper tapes are drawn lengthwise outside the insulated wire, and three others outside the former, but overlapping the junctions of the inner tapes, as shown in sketch Fig. 5 (enlarged). These tapes all pass through guides and rubbers, and through a heated conical die, supplied with molten metal. As it passes out of this it is chilled by a trickling stream of water, and skimmed as it passes through a

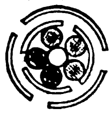

FIG 5

FIG 6

tubular dresser, and shows in section as a clean thin tube as shown, natural size for telephone, incandescent lighting, &c., at Fig. 6.

REVIEWS.

Electrical Instrument Making for Amateurs. By S. R. Bottone, Certificated Science Teacher, South Kensington. (Whittaker and Co.)

This is a book by an amateur for amateurs, and though not perfect, should do a considerable amount of good, especially if read in conjunction with some sound elementary text-book.

As long as the author confines himself to plain mechanical instruction how to put together rough but working apparatus, we can fully appreciate the value of his instructions. Let no one despise home-made work who has seen what Prof. Hughes can do with a few bits of iron, straw, and string; and an instrument, however rough, which a boy makes for himself, will teach him far more practical science than the very best he can buy in the shops.

The first half of the book is devoted to static electricity, and reminds us of a certain "Boys' Own Book" which we used to devour in our infancy. It is, however, fairly practical and good all through.

In the second half, dealing with electro-dynamic work, the author occasionally gets far astray. His directions for making and calibrating a voltmeter are fairly good, but we rather pity the amateur who tries to get the 1 ampere point on his ammeter by Mr. Bottone's method, viz., by trial and error to obtain a deposit on the cathode in a voltameter of exactly 18·35 grains of copper in one hour; there are sundry other minor beauties in the method which will be found at p. 120.

In the preface we are told that "nearly all the really useful inventions and discoveries of the nineteenth century must be attributed to amateurs." The following receipt is doubtless one of the discoveries alluded to, and for simplicity and clearness quite puts Mr. Kapp's professional paper of last year in the shade:—

"*To make an armature to give* A *amperes and* V *volts.*—Take V yards of wire $\frac{A}{1000}$ inch section, and make the armature just large enough to hold it. N.B.—For machines under 2cwt. allow more than V yards of wire." (Pp. 111-12.) Mr. Bottone is also seriously in error when he says that the magnetising force of an ampere-turn varies inversely as the square of its distance from the iron core. This is a mistake often made by amateurs, who find it difficult to realise the fact that the magnetising force of a layer of wire surrounding an iron arc and carrying a given current is *totally independent* of the radius of the coil.

On the whole it is really a great pity that Mr. Bottone did not get an electrician to look through his proofs, as it would have saved him making these and sundry other errors in an otherwise very useful book.

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LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

Chapter VIII.—*The Calibration of Current Indicators.*

(Continued from page 506.)

93. *Use of the "Shunt."*—The sensitiveness of an indicator can be reduced by "shunting" it—that is, by connecting a resistance to its terminals; part of the current then flows through this resistance or is "shunted" past the instrument. A box containing resistance coils in which the resistance may be adjusted to any value by means of plugs, as before described, is connected to the terminals of the most sensitive indicator. This resistance so connected is technically known as a "shunt" on the instrument, and its duty is to conduct away a portion of the current, so that only a certain part of the current, say $\frac{1}{n}$th, flows through the instrument. If, then, we observe the current flowing through the instrument so shunted, we know that the current in the main circuit is n times as much. The value of the number "n" is then what is termed the "*multiplying power*" of the shunt.

94. *Practical Case of the Application of Shunts.*—A practical instance will best serve to make the action of the shunt clear. In Fig. 54, A B and C represent three indicators of different degrees of sensitiveness, which were calibrated at the same time. A few preliminary observations were taken, employing one secondary cell of negligible resistance and of 2 volts E.M.F. This was circuited in series with an adjustable resistance box, and the three instruments as shown. All three instruments had their needles suspended horizontally by silk fibres, but the instruments were very different in other respects. A was an astatic instrument, similar to that shown in Fig. 49, and wound to 544 ohms, B was a Walmesley-Mather instrument wound to 192 ohms, and C had a small needle surrounded by a large circular coil, constituting ordinarily a tangent galvanometer, but employed in this case with its coils moved out of the magnetic meridian by 60 degrees. This instrument was wound to 253 ohms, and the divided scale over which the needle could be deflected was marked out into 200 divisions. Before any instrument was shunted, it was found that with one cell in circuit A was deflected 80 degrees, B 52 degrees, and C 74 degrees, 11 ohms being unplugged in the resistance box, which, added to the total resistance of the instruments, made up the entire resistance of the circuit to an even 1,000 ohms. The deflection on C, which should be nearly 200 divisions, was too small, this instrument being the least sensitive, and therefore another cell was added to increase its deflection. Now, this increase in current increased the deflections on A and B also, and therefore shunts were put on them; but as it would never be possible to to obtain a deflection as great as 90 degrees on these two instruments (their coils being parallel to the magnetic meridian) it may be asked, why should they be shunted at all? The reason is that if the needle of an instrument is deflected very near 90 degrees it requires the addition of very large resistances in the circuit to reduce this deflection down to a very small angle. For the purpose of calibration it is sufficient to deflect up to 70 or 80 degrees, and, therefore, the deflections on A and B were reduced to about 75 degrees by the addition of shunts of such values that only $\frac{1}{5}$ of the current passed through A and $\frac{3}{4}$ through B—that is, the multiplying powers of these shunts were 5 and $\frac{4}{3}$ respectively. There were then conveniently large deflections on each instrument, viz., 74½ degrees on A, 74 degrees on B, and 187 divisions on C. This was with 94 ohms unplugged in the resistance box, which, together with the resistance of the instruments (A with shunt = 109 ohms, B with shunt = 144 ohms, and C unshunted = 253 ohms) made up an even 600 ohms; the main current was therefore $\frac{4 \text{ volts}}{600 \text{ ohms}}$ in amperes, or 6·6 milliamperes.

95. *Calculations to be Made when Shunts are Employed.*—From the above practical case of the use of shunts it will be noticed that there are one or two little calculations to be made when they are employed, viz.:—

(1.) What is the ratio between the current in the main circuit and that passing through the instrument, shunted with a given resistance, or, in other words, what is the multiplying power of a given shunt?

If we call this ratio "n," it is clear that $\frac{1}{n}$th of the main current passes through the instrument, and therefore we must multiply the current passing through the instrument by n to find the value of the main current. Hence, the ratio n of the two currents is known as the "multiplying power" of the shunt.

In Fig. 55 an instrument is shown with a shunt attached to its terminals 1, 2; the main current arriving at terminal 2 divides between the two paths open to it, these two currents recombining again at terminal 1 and passing on. There must be a certain difference of potential between the terminals 1 and 2, or there would be no current, and this difference of potential is the same for both instrument and shunt, since both are joined directly to the terminals 1 and 2. Therefore, by Ohm's law (para 50) the currents through these two paths are proportional to their respective conductivities, and the sum of the two currents, *i.e.*, the main current, is also proportional to the combined conductivity of the two paths. From this consideration we have at once the relation between the main

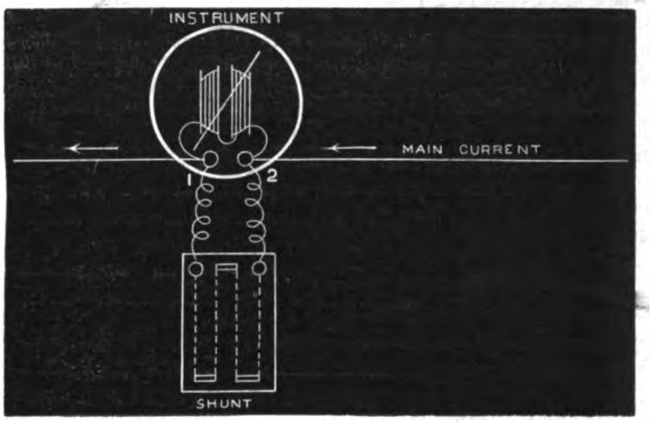

Fig. 55.

current and the current through the instrument expressed in the following proportion:—

main current : current through instrument :: combined conductivity : conductivity of instrument.

Representing, as above, by the letter n, the ratio between the two currents in the first and second terms of this proportion, we have

$$n = \frac{\text{combined conductivity}}{\text{conductivity of instrument}}.$$

It is, however, more convenient for practical use to express n in terms of resistances instead of conductivities, and we know that the conductivity of the instrument is

$$\frac{1}{\text{instrument resistance}},$$

and the combined conductivity of instrument and shunt is

$$\frac{1}{\text{instrument resistance}} + \frac{1}{\text{shunt resistance}};$$

whence we get

$$n = \frac{\dfrac{1}{\text{instrument resistance}} + \dfrac{1}{\text{shunt resistance}}}{\dfrac{1}{\text{instrument resistance}}},$$

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Dividing it out we have

$$n = 1 + \frac{\text{instrument resistance}}{\text{shunt resistance}},$$

which is the usual expression for calculating the multiplying power of a shunt. Expressed in words, *the multiplying power of a shunt is found by dividing the instrument resistance by the shunt resistance, and adding unity to the quotient.*

(2.) When a given multiplying power, n, is required, what must be the resistance of the shunt? This is at once derived from the last result, from which we obtain

$$n - 1 = \frac{\text{instrument resistance}}{\text{shunt resistance}},$$

and therefore

$$\text{shunt resistance} = \frac{\text{instrument resistance}}{n - 1}.$$

Applying this to the practical examples of the shunted instruments in para. 94, instrument A (of 544 ohms) was shunted with a shunt of multiplying power 5, and therefore the resistance of this shunt was

$$\frac{544}{5 - 1} = 136 \text{ ohms}.$$

Instrument B (of 192 ohms) was shunted with a shunt of multiplying power $\frac{4}{3}$, or $1\frac{1}{3}$; the resistance of the shunt was therefore

$$\frac{192}{1\frac{1}{3} - 1} = 192 \times 3 = 576 \text{ ohms}.$$

(3.) What is the combined or joint resistance of the instrument and shunt together?

The joint resistance of two or more resistances in multiple arc is the exact converse of their combined conductivity para. 41). The combined conductivity as given before is

$$\frac{1}{\text{instrument resistance}} + \frac{1}{\text{shunt resistance}},$$

which, when brought to a common denominator, equals

$$\frac{\text{shunt resistance} + \text{instrument resistance}}{\text{instrument resistance} \times \text{shunt resistance}},$$

and the required joint resistance is the reciprocal of the above. We have, therefore,

$$\text{joint resistance} = \frac{\text{product of the two resistances}}{\text{their sum}}.$$

If, as is usually the case, the shunt is arranged for a definite multiplying power, n, we may arrive at the joint resistance from the value of n by a very quick and easy way. For it will be seen that if the expression above for the combined conductivity be split into two factors, one of which is the conductivity of the instrument, we have the combined conductivity

$$= \frac{1}{\text{instrument resistance}} \left(1 + \frac{\text{instrument resistance}}{\text{shunt resistance}}\right),$$

and the remaining factor enclosed in the bracket will be recognised as n.

Therefore the

$$\text{combined conductivity} = \frac{n}{\text{instrument resistance}},$$

and the reciprocal of this gives the

$$\text{joint resistance} = \frac{\text{instrument resistance}}{n}.$$

This latter expression is very frequently used, since n is generally known first and the joint resistance calculated afterwards.

Applying this again to the practical examples in para. 94, the joint resistance of A and shunt was

$$\frac{544}{5} = 109 \text{ ohms},$$

and that of B and shunt

$$\frac{192}{1\frac{1}{3}} = 192 \times \frac{3}{4} = 144 \text{ ohms}.$$

Although the calculations with shunts have taken some time to describe in words intelligently, it will be seen that the calculations themselves are very simple.

96. *Calculation of Actual Current through each Instrument and Plotting of Curves.*—Continuing the details of the practical example of the three instruments in para 94, after once adjusting the shunts, these have not to be altered again during the whole test, and therefore there is in the circuit a permanent resistance, comprising

Joint resistance of A and shunt	......	109 ohms
„ „ B „	......	144 „
Resistance of C alone	......	253 „
Battery		negligible resistance
		506 ohms

and with the permanent addition of 94 ohms in the resistance-box, the total resistance was made an even 600 ohms, this being increased by 100 or 1,000 ohms at a time, so that the resistance in circuit was conveniently always a multiple of ten. Two secondary cells of negligible resistance and 2 volts per cell having been used for this test, the main current passing through Instrument C corresponding to each reading was

$$\frac{4 \text{ volts}}{\text{total resistance}} \text{ in amperes.}$$

The current through B corresponding to each reading was $\frac{3}{4}$ of the above main current, and, similarly, the current through A was $\frac{1}{5}$ of the main current.

The curves were then plotted for each instrument in precisely the same manner as explained previously, each curve showing the relation between the deflections and corresponding currents through the instrument.

(To be continued.)

Minor Phenomena of the Incandescent Lamp.—We take the following from the *Scientific American*:—"The incandescent electric lamp has already been cited as giving an illustration of irradiation. When in full action, it presents no longer to the distant eye a simple loop of glowing carbon. By irradiation the outline is lost, and it resembles a gas flame. The same object illustrates very perfectly some of the phenomena of persistence of vision. If an incandescent burner is gazed at while near the eye the filament can be distinctly seen. Now, if the eye is closed, the image of the filament remains, and appears in clear outline in a purplish or violet colour. The characteristic shape of the particular filament is especially distinct. If, in looking at it, particular care is taken to avoid remembering its appearance (and this disciplining of the mnemonic faculty is not difficult), the spectral image seen with the closed eye will vividly portray the filament and its peculiarities. Sometimes it seems as if the effects of irradiation could be partly overcome; as if the image of a distant lamp could be reproduced free from the glow of irradiation. To a degree this may be possible, but a fully ignited and distant lamp always gives a confused spectral image to the closed eye. The filament of the high resistance lamps illustrates elasticity very well. Surrounded by a vacuum, so as to be free from the damping effects of the air, no object more sensitive to vibrations or shocks can be found. The least tremor of the wall to which the lamps are attached makes the loop vibrate for a long period. This only takes place when they are cold. When the current is passing and they become red or white hot, they are no longer so elastic, and cannot be made to vibrate as before. By the same vibrations sound is often produced. The vacuum of the globe prevents the sound from being heard by atmospheric transmission. But the filament is in solid connection with the globe and socket. If it is set in strong vibration, and the lamp is held pressed against the ear, a ringing metallic sound will be heard. This cannot be done with all burners. A certain size is naturally essential, as the sound is at best a weak one. It would seem possible that a visual seismograph of extreme sensitiveness could be made on the general lines of an incandescent burner. It is probable that a filament could be obtained in this way more affected by external vibrations than is the most sensitive device now used."

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A MECHANICAL TEMPERATURE COMPENSATION FOR THE BIFILAR MAGNETOMETER.

The bifilar magnetometer is the instrument generally employed for determining the variations in the horizontal component of the earth's magnetism. When the observations are taken frequently, every hour for example, the corrections necessary on account of change in the temperature involve a large amount of laborious calculation. The effect of an increase of temperature is to diminish the magnetic moment of the magnet, and to increase the twisting couple due to the suspension.

In the *Zeitschrift für Instrumentenkunde* for January, Dr. Liznar describes a method by means of which he has succeeded in entirely obviating the necessity of calculating temperature corrections.

The torsion-head of the magnetometer is rigidly attached, by means of a brass collar, to the centre of a glass rod, which is thereby fixed in a horizontal position. This collar carries two other brass collars rigidly connected with it. Through these collars slide two zinc rods parallel to the glass rod, and capable of being fixed in the collars by means of screws. Two movable brass collars sliding on the glass rod and capable of being fixed in position by screws, carry adjusting screws by which the distance between the adjacent ends of the zinc rods can be regulated. The extremities of the platinum suspending wires are attached to these ends, and when the adjustment is made, the zinc rods are rigidly fixed at the desired points of their length to the glass rod by means of two double brass collars sliding on the rods, and capable of being tightened by means of screws.

The author shows that when the coefficients of expansion of glass, zinc, brass, and platinum are known, the available length to be given to the glass rod, in order that the increase of temperature may cause such an approach between the points of suspension as to keep the ratio of the magnetic moment of the magnet to the twisting couple constant, is determined—namely, the points at which the zinc rods are to be permanently fixed to the glass rod are determined. The author's method has been thoroughly tested, with the most satisfactory results.

In a series of observations with a magnetometer supplied with this arrangement, extending from January to June of last year, the temperature coefficient was found to be completely eliminated, having previously been about 3 scale divisions per degree centigrade. As the range of temperature was 6·78° C., the range of the variation in the readings, due to change of temperature, would have been at least 21 scale divisions.

G. W. T.

THE NON-EXISTENCE OF THUNDERBOLTS;

Elucidated by Accounts of Searches after them and the Exhibition of Specimens.*

BY G. J. SYMONS, F.R.S., SECRETARY.

The survival, down to the present day, of a belief in the existence of thunderbolts is a striking proof of the superficiality of modern teaching, and of the slight extent to which even the most elementary notions of electricity or physics have penetrated the mass of our countrymen. I hope that there is not one of our Fellows that has not long abandoned the belief; but, in case there should be one such, I have obtained the permission of our council to try to convert him.

Of course the belief in the fall of material substances during thunderstorms is merely the survival of the mythical bolts which irate Jupiter hurled at his enemies; but that the notion should still prevail with a population which may be said to be living in an age of electricity, and to be surrounded by telegraph, telephone, light, and bell wires, above our heads, below our feet, and running all through our houses, is passing strange.

Our President has illustrated to you that a flash of lightning is nothing but a large electric spark, an equalisation of potential between two unequally or differently electrified bodies; and there is no more transmission of a thunderbolt or any material substance than is there actual transmission of material substance when we send a message across (or rather under) the Atlantic.

* Read before the Royal Meteorological Society, March 21st, 1888.

I have been looking out for a real thunderbolt for over thirty years, and I am going to tell you very briefly the true history of several (so called).

Notting Hill.—On July 2nd, 1866, one of the London daily papers startled some of its readers by inserting a letter on the thunderstorm of June 30th, in which the writer said, "At six o'clock the storm broke out again with increased violence, the rain descending in torrents, and at a few minutes past seven a thunderbolt fell in the gutter opposite my house (in Westbourne Park, Notting Hill), and was smashed to pieces, one of which I have at the hour at which I write. Numbers of persons are still searching for the fragments."

Feeling certain that there was a weak point somewhere, inasmuch as "thunderbolts" have no existence, I called on the writer of the letter and other residents, found the story amply confirmed, received several pieces of the "thunderbolt," which were fragments of coal, a supply having been unloaded to the next house the day previous (by-the-bye, some were sold at 10s. and 15s. each), and eventually I ascertained that one of the pupils of an analytical chemist had availed himself of his tutor's absence to fill a capsule with materials calculated to burn vigorously and explode in heavy rain, and during the height of the storm, had thrown the burning mass into the gutter, so making an artificial thunderbolt. It is no wonder that the neighbourhood were taken in by a trick so well arranged.*

Kilburn, July 5th, 1877.—This is a very circumstantial story, and I am glad to be able to exhibit two pieces of the thunderbolt (?) and a photograph of the third. I append the account as given in the local paper,† but will summarise the leading features of what I believe to have been the real facts. A small street turning out of the Edgware-road, chiefly occupied by stables, contained also the premises of a local fire brigade. A telegraph wire crossed this street; an exceptionally strong flash of lightning struck, broke, and perhaps fused the wire; part of the wire fell on a little girl's hair and burnt it; other fragments fell in the street, where there was a blaze of light from the flash. Subsequently it was found that the street was strewn with clinkers—so called even by the newspaper—and these were described as thunderbolts. I think that most probably they had been raked out of the steam fire engine, but at any rate there are two difficulties which require expla-

* *Meteorological Magazine*, Vol. I., p. 66.

† FALL OF A THUNDERBOLT IN KILBURN.—The storm which burst over the metropolis about 8 o'clock on Thursday, 5th July, is described as being very severe in places, but it would certainly appear that Kilburn had the severest part of its viralence [*sic*], as a ball of fire of immense size fell in Bridge street, spreading consternation in every direction, but, happily, as far as the destruction of property is concerned, little or no damage is done in the street The telegraph wire, running from Mr. Carpenter's shop to Kilburn Park-road, was, however, completely fused, small fragments only being left, whilst the upper window of Mr. Brown's premises in Oxford-road was shattered. The scene is described as follows by several persons in the vicinity:—

"Shortly after eight o'clock a most vivid flash of lighning was observed, followed by a crash of thunder. This was succeeded by another, and then the most terrific crash, like the discharge of one of Krupp's guns, or the Woolwich infant, and with it fell the ball of fire or thunderbolt, to which we have alluded. This appeared to pass over with lightning rapidity from the direction of the Queen's Arms, and fell in huge masses into Bridge-street, from the door of the fire station up to the top of the street. The whole district for some seconds appeared to be enveloped in flame; the women screamed and in some cases fainted. The molten liquid, which poured down from the infuriated heavens, on reaching the ground at once coagulated, forming a clinker so heavy that in many cases they weighed over a pound and a-half. Meanwhile the place was enveloped in a thick bluish yellow smoke, very objectionable, which did not clear away for some ten minutes. Persons residing in the Kilburn Park-road made sure, from the spreading of the fire, that houses in Bridge-street had been struck and were in flames. A little girl named Frost, living at 6, Bridge-street, was struck on the head by some of the molten liquid and had her hair seriously burnt, but no dangerous symptoms are apprehended. After the flash of lightning alluded to, Bridge-street was literally strewn with a mass of clinkers; and it is estimated that were they all collected together there would be nearly two bushels of them, in size from a walnut up to a man's hand, and weighing very heavy. Simultaneously with the falling of the bolt in Bridge-street, as we have already noticed, the wire which crosses from the Post Office in Manor-terrace to the Kilburn Park-road was completely fused, small particles falling in every direction. . . . . . . Pieces of the clinker can be seen at the *Kilburn Times* Office.—*Kilburn Times*, July 7th, 1877.

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nation :—(1.) How clinkers are formed in the sky ? (2.) Why they all fell in the street, and not one pierced a roof or broke a skylight ?

Chelsea.—On June 26th, 1880, at 3 p.m., there was a sharp thunderstorm in the west of London, and it was reported that a thunderbolt had struck No. 180, Oakley-street, Chelsea, and had been found in the kitchen grate. It was further stated that it had been broken up with the poker, but that a specimen could be seen at the office of the *West Middlesex Advertiser.* This sounded rather tempting, so I went. The lump which was shown to me was an agglomeration of brick, soot, unburnt coal and cinder. I suppose that no one would suggest that bricks are manufactured in the atmosphere, or that unburnt coal is another probable component. The case was unusual because ordinarily, on a lightning discharge descending a chimney beneath which a fire is burning, it scatters the burning coals over the floor. In this instance it seems, as usual, to have swept the chimney, taking down also some fragments of brick, and then finally to have fused the contents of the grate into a cake, thus producing this so-called thunderbolt. I am sorry that all the specimens have been lost.

Surrey.—I have not the date nor precise site of this fall; but, on the other hand, thanks to one of our Fellows, I have the thunderbolt (?). The story is very short. There was a thunderstorm, the lightning was seen to strike a manure heap; a hole was found in it, and on opening the heap this ball was found. Unluckily for the theory of the existence of thunderbolts this proves to be an old cannon ball! by which the direction of the flash had perhaps been partly directed.

Casterton.—Another illustrative case has come to my knowledge in connection with the present Exhibition. A large nodule of red sandstone has been sent, which had been found in circumstances which very naturally led to its having been regarded as falling from the sky; but it is simply a natural formation of the soil where it was found. The narrative runs somewhat thus :—A gentleman, his wife, and three daughters were looking out on a lawn at Casterton, in Westmoreland, during a thunderstorm, when they considered that they saw the stone fall through a tree, kill a sheep, and bury itself in the ground. After the storm the dead sheep was found, and a hole, and at the bottom of the hole this stone, which was forthwith described as a thunderbolt.

A very slight modification in the account will remove the romance, and show that the phenomena were of the most ordinary description. I venture to suggest that they saw the lightning strike the tree, the lightning killed the sheep, and then, as is not infrequent, in rushing into (or out of) the soil formed a hole. A nodule like this would be difficult of expulsion, and therefore the stone remained at the bottom of the hole.

There are several facts which have been twisted into imaginary support of the theory of the existence of thunderbolts

1st. There are the often approximately spherical nodules of iron pyrites which are so frequently found in the chalk. Their weight and their structure when broken harmonise so well with mythological notions, that it is not to be wondered at that many of them are still preserved as real thunderbolts.

2nd. Belemnites—which, by-the-bye, I see "Webster's Dictionary" says are called "thunderstones"—which are really fossil animals, are frequently preserved as thunderbolts.

3rd. If a heavy discharge of lightning falls on a bed of sand containing much silex it usually penetrates it for many feet; and along its path it fuses the sand into a sort of glass, thus producing what is known as a fulgurite (of which several very fine ones are in the British Museum). Portions of these fulgurites are sometimes considered to be thunderbolts. I regret that I have not been able to procure a specimen for the Exhibition, but there are two valuable drawings by Herr Dr. Fiedler, reproducing two—one of them nearly 9ft. long—of their natural size. And there is also a beautiful engraving of part of one in Ribbentrop's paper on "Fulgurites.*

* "Ueber die Blitzröhren oder Fulguriten," von G. Ribbentrop. Braunschweig: 1830.

4th. Sometimes aerolites or meteorites fall during thunderstorms. There is absolutely no connection between the two phenomena, but in the very rare cases where they have happened at the same time, the meteorite has, of course, been instantly designated a thunderbolt.

For our credit as Englishmen we ought to drive the word thunderbolt out of our dictionaries. Everyone can help to do this, and the greatest help of all will be, whenever one hears of a thunderbolt having fallen, not to content oneself with a shrug of the shoulders and an ejaculation as to popular ignorance, but to go to the spot, patiently examine the facts, and then explain publicly precisely what has happened. Thunderbolts require only to be brought to the light of modern knowledge to be at once annihilated.

THE DISTRIBUTION OF ELECTRICITY BY ALTERNATE CURRENTS.*

BY T. CARPENTER SMITH.

The distribution of electricity by means of alternating currents, though comparatively new in this country, has already reached such an enormous importance that it is with great hesitation that I venture to speak upon it, even though limiting myself to the strictly practical side of the work, dealing only with the apparatus as we receive it from the hands of the manufacturer, and leaving out entirely the question of the efficiency of dynamos and converters. It is only the knowledge that the mistakes of those who enter upon any new line of business are the rounds of the ladder by which we all attain success that emboldens me to lay before you some of the conclusions at which I have arrived after several years' experience of varied types of electric lighting, both by the arc, by the direct-current incandescent, and the alternate-current incandescent.

The subject naturally divides itself into several heads, but I would first say that it appears impossible to lay down any general plan of distribution, which shall be practicable in all cases. In almost every town a different plan will be required, and this will depend in most cases purely on local circumstances. Systems and methods that would be admirable for thickly settled and densely populated districts will not be successful in thinly populated and widely scattered ones. I wish it to be understood that, whenever I speak in this paper of success and successful systems, I mean successful entirely in a commercial way, and the conditions of this commercial success will vary in every town and district. I will therefore content myself with describing the method which I have found to be most successful in the various districts with which I have had actual experience, and leave it for those who may be called on to design and lay out the lighting of any particular district to judge for themselves which line of action to pursue.

Naturally, the first part of my subject is the dynamo, and the station detail. I have tried the large and small dynamo, and have concluded that it is a very great point to properly proportion the unit size of dynamo to the probable size of the station; that is, not to have dynamos of different sizes, but to first determine what the unit shall be, making it as large as possible, and then make your whole apparatus additions to that unit size. This simplifies matters very much, enabling machines to be interchangeable, both as regards their parts and their work, and this I am sure will be admitted by all who have ever had the annoyance of a breakdown on engine or machinery, when perhaps they had standing idle plenty of apparatus which, from various circumstances, could neither be used itself nor be robbed to repair the breakdown.

I would drive each dynamo by a separate engine, and this for several reasons. By proportioning the engine to the dynamo it will be possible to have the engine running slightly overloaded when the dynamo is doing its utmost during the hours of heavy lighting; and as this extreme load falls off to the lighter hours of running the engine will be working at its

* Paper read before the American National Electric Light Association, at Pittsburgh, Feb. 23.

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point of best economy, instead of running underloaded, and thereby wasting steam. Thus, we use in our station on Virgin Alley dynamos of 2,500 lights capacity each, driven by 200 horse-power engines. During sixteen hours of the day these dynamos run, driving 2,000 lights, and the engines are cutting off at quarter stroke, and developing 200 horse-power. During the other eight hours we have driven these dynamos as high as 2,800 lights, during which time the engine was of course overloaded, and not working to so good an economy; but eight hours of overload is not nearly so wasteful as sixteen hours of underload. Again, we have had it very forcibly demonstrated more than once that if the engine be only large enough to drive the dynamo with ease, a heavy short circuit on the mains outside will simply pull the engine up or slow it down without destroying the dynamo, and only those who have seen a 9ft. fly-wheel running at 250 revolutions per minute on a 200 horse-power engine slowed right down in almost an instant of time can realise the terrific strain to which everything is subjected in such cases, and I would mention right here that the element of time is a very great factor in such circumstances, as in an accident of this kind mischief is often done before the safety catches can melt out. The direct belting of the engine to the dynamo is always to be preferred; shafting is, except under exceptional circumstances, simply a nuisance for incandescent electric light stations, and the economy of one large engine over many small ones has been enormously overrated. For arc light work, where the lights are all lit and extinguished at certain hours, the large engine is good; but for incandescent work, where the load is absolutely out of the control of the station, it is impossible to steadily run a large engine at anything like its most economical load, whereas, with separate engines, the machines can be started and stopped the moment that they are needed or are done with, while the oil from shafting will always cause more or less grease and dirt.

For central station use, except for very small plants, I should certainly use separately excited dynamos, and should do the exciting from two or more dynamos, each capable of exciting the whole system. In this way, with the station running at its normal, the only regulation required is that obtained by working the single rheostat in the field of the exciter, and, as we have designed our station at Pittsburgh, this will mean the regulation of 15,000 lights by one six-inch hand wheel. Of course, each dynamo should have its separate field rheostat, to make up for any slight difference in speed of engines. The two exciters should be so arranged that they can be run together or separately, or that either can do the whole work, which of course is easily accomplished by feeding them into a separate pair of exciter bars on the switch-board, and charging the fields of the alternating dynamos from these. The general question as to whether it is better to use separate circuits for separate machines, or to couple them into a general set of 'bus wires and distribute from them, is too large to be lightly decided, as also is the question as to whether it is best to run separate circuits for separate districts or to run into a general system of high-pressure mains outside of the station, feeding into these mains at different points, and again distributing from them; and I am not prepared to express any preference, but think that local circumstances will generally decide this question. There seems to me little doubt that in underground systems the network of high-pressure mains would be the best, but for overhead work we have adopted the system of separate circuits from separate dynamos, using a switchboard which enables us practically to run any circuit or any number of circuits from any dynamo, and running these dynamos separately and not in multiple arc. In spite of the utmost precautions, the unregenerate telephone and telegraph men are always hauling wires across our high-pressure mains and feeders, and while their wires and not ours generally suffer, after hearing the frightful roar that comes from the dynamo which is running the particular circuit so crossed, we always feel relieved to know that only one dynamo is in danger of being thrown out by the slipping off of the belt—and a 20in. belt is not a pleasant thing to have flying around loose. In case of any trouble, such as fire, circuit broken down, or anything of that sort, we can pull the switch of that particular circuit until we can cut out the part affected. The system that I have laid out for use here will of course take a long time to introduce, in view of the fact that we are changing from one system to the other, and have to be governed largely by the location of our lighting, our existing lines, and the possibility of putting up additional pole lines; but it takes, in my vision, the form of a series of heavy mains down the main streets, with cross lines on the cross streets, with switches on the poles, enabling any of the cross streets to be run from the mains on either of the main streets, so that, in case of fire on one of the main streets, the section represented by the block in which the fire occurs can, by the pulling of two switches, be completely cut off, while the cross streets on either side of the section will enable the lights beyond the fire or broken circuit to be operated, with only the trouble of a slightly larger percentage of loss and the consequent dimming of the lights.

For the main overhead wires I must harp upon the old string, which cannot be struck too often, namely, high insulation. For 100-volt current work the old stand-by of "undertakers'" wire will pass, but when it comes to 1,000 volts difference of potential, and 130 or 140 amperes to back it up, one realises very quickly that nothing is too good to curb this fiery steed. We are still paying the penalty of early ignorance in having many circuits of underwriters' wire stretched upon our poles, and I have stood and listened with fear and trembling to the howls of a new dynamo which had only been in operation for a few hours, when we had four short circuits in as many minutes, caused by dead wires falling across these mains on wet days; while, on the other hand, I have been gratified beyond expression to see our linemen remove ten or twelve old bare iron "district call" wires, which had been hanging all night right across our high-pressure, high-insulation mains, and this during a soaking rain. Especially should the service wires to the converters be of the best insulation, not only for fire, but for protection to life; for, while the shock does not kill, even a 100-volt shock may make a man start so as to fall off a ladder—and any death or injury will be credited to the electric current. We have adopted a standard of a separation of three feet between the two wires nearest each other on our cross-arms, and do not allow, under any circumstances, the tapping of service lines directly to these wires. All services must be attached through the medium of a small spreader on the end of the cross-arm, which I have no doubt all those present have noticed on the streets.

In some districts, where the number of lights in each building is small, we run secondary low-pressure mains, and place the converters on the poles, and make our distribution from our secondary mains; but our experience has been that this is not a very satisfactory way of doing. The percentage of loss on these secondary mains, unless the wires are very large or the converters very numerous, either of which is objectionable, causes such a decided variation in the lights as to give grounds for numerous complaints.

The question of the loss on the high-pressure feeders and mains is one which I think has not received enough attention. When the alternating system was first introduced, so much was said about the extreme smallness of the wire required that a great many of the arc light fiends throughout the country, who had been accustomed to congratulate themselves on the fact that No. 6 wire was big enough for a 20-mile circuit, immediately jumped to the conclusion that, because it was a high-tension current, No. 6 wire was big enough for all cases; and consequently more than one case of dreadful grief has arisen. I have laid out our circuits on a certain fixed plan, which is, that each circuit shall be laid out for 1,300 lights (that being the size of unit which we at first adopted), and made of such sizes as to carry these 1,300 lights with a loss of not more than 2 per cent. with the whole load on. By having feeders large enough for this we prevent any noticeable difference in candle-power from one end of the circuit to the other, and should we be even compelled to run a light circuit and a loaded one on the same machine the increase in the one or the decrease in the other would not be injurious. Of course we try to so arrange our circuits that the load shall vary about

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the same on each, but the suddenness with which storms creep up in Pittsburgh makes our load very uncertain and erratic. We have run for three days and nights with only a little more than half of the machinery in operation, and then from Monday night to Friday morning have had to run every incandescent machine in the station under a load that fairly staggered it.

I now come to the question of the placing of the converters, and for this I think you may safely lay down the general rule that wherever you are simply carrying current do it at high pressure, and keep your low pressure for the purely local distribution. With proper precautions, I do not see that there is any real danger in carrying the high-pressure wires into and through the building. If a 1,000-volt current from a central station is not to be allowed in a building on account of its dangers, then every arc light plant—whether from central station or an isolated plant in the building—must be condemned for the same reason. Of course, the cases where two wires of an arc circuit with a difference of potential of 1,000 volts are run close together are not nearly so many as must be the case where there is a constant difference of potential of 1,000 volts in the alternating system; and again, of course, we have the fact that the direct current on arc circuits is generally not more than 20 amperes, while, as I have remarked before, our alternating circuits run as high as 130 amperes; but the fact that one is a direct and the other an alternate current largely makes up for this difference. With all due respect for the many gentlemen who have discussed so learnedly on the deadly alternating current, and on the frightful results therefrom, and whose experience with the alternating system is mostly confined to the magneto bell or induction coil, I must maintain that the alternating current, while it is in mild doses of from 100 to 200 or 300 volts intensely more disagreeable than the direct current of the same voltage, when it comes to 1,000 volts, or more, it is very much less dangerous to life. I make this statement with the more confidence that I have tried them both, and we have in our station here not one but half a dozen cases where our linemen and dynamo men have received the full 1,000 volts, generally being pretty badly burned at the point of contact, but experiencing no ill after effects; while, whenever any of our men receive a shock from one of our arc machines they are nearly always sick for a day after. This very fact of the alternating current being more disagreeable adds to its safety, as the men are disinclined to work on the wires, even when there is only a slight leak, where with the direct current they will often take much greater risks. In carrying our high-pressure wires through the buildings, we have adopted the invariable rule that they must be carried on porcelain insulators, and the wires themselves waterproof in all cases. We do not allow them to be run in moulding, but where the wires are to be concealed or protected, a casing is run around the wires outside of the porcelain insulators, giving them a perfect air insulation, and hard rubber must always be used for floors and walls. The converters are all placed with porcelain knobs behind them, giving an air space of two inches between them and the wall, and we prefer in all cases to put them against brick rather than against wood or plaster. I understand that in some districts the use of converters inside buildings has been forbidden, but I think that this position is a most unjust and untenable one. The only argument that can be brought against their being placed inside is the danger to life or of fire. For the first, the converter is well insulated, and is placed high up out of reach, and, most potent argument—though one I am sorry to say often refused recognition—it is not placed there to be handled. As regards the danger from fire, all the converters with which I have had any experience are boxed up completely in iron cases, the only opening in which is a small one at the bottom for ventilation. They cannot possibly get hotter than the melting point of lead, for the simple reason that if they should the fuses would blow out and cut them out of the circuit, and any one who has performed the old experiment of melting lead in a piece of paper, can easily see that this heat is not liable to set anything on fire, and even should the converter burn out, no flame can escape from it to set fire to anything, however inflammable. If the converter is to be banished from buildings on account of danger from fire, then every stove, high-pressure steam-pipe, and for that matter every gas jet, must also be banished.

In a Chinese firecracker lately published I find the statement that Inspector McDevitt has relegated to the cellar all converters, and that he says that in the first case of explosion or fire from them they will have to go to the street. Now, as vice-president of the company owning these converters, I have simply to say that this is not so, and that the converters are placed all through the buildings, wherever we may desire to have them, and only three or four are in cellars. Moreover, so far from Mr. McDevitt making any such statement, he has steadily refused, even under the most urgent solicitation of the Chinese gentlemen, to make any such restriction, but has very properly stated that until an explosion or fire occurred he can take no such action.

As regards the liability to burn out, and the danger therefrom, I can only say that from over 600 converters of all sizes, from five to fifty lights each, in an experience extending over twelve months of constant service night and day without any stop, we have had but three actual cases of burning out, two of these being 5-light converters, and one being a 50-light converter. The two 5-light converters were simply slowly roasted out from overloading, until finally the insulation on the primaries was charred through, when the fuse blew out instantly, and all was over. In one case the customer had been attracted by the converter singing, and was standing looking at it when his lights suddenly went out, and he had to go into a neighbour's store to know whether the trouble was in his lights only or with the main circuit. The 50-light converter suffered in the same way, having nobly endeavoured for some two days to run 120 lights. It was one of three on a section of secondary mains, and the lineman who had been sent out to examine them, owing to complaint to us of poor light, reported that two of them were all right, as they were cold, but that one of them was bad, as it was very hot; and preparations were being made to change this converter, when a message was received from one of our customers that the "stove on the pole" in front of his place was smoking.

Investigation showed that both plugs in the other two converters were blown, and the only reason that this one had not followed suit was the fact that some ingenious gentleman had made them of copper. We have had three cases of defective converters; that is, converters with a wire broken inside, or short circuited, so that the moment that the current was put into them they would blow out all the fuses, and if new fuses were put in they would again blow; but the men in these cases, of course, immediately returned them to the shop for examination. That is to say, out of the 600 convertors, we have actually had to remove or repair one per cent. in actual service; and I submit that, on a total convertible capacity of 17,000 lights, this is a very good proof that these converters are well made and not dangerous.

In all of our experience we have not had one single case of connection between the primary and secondary, or the primary and the shell of the converter, even in the case of the burned-out converters, and we had, just a few days ago, the first case of a connection between the secondary and the shell of the converter.

We started in with the idea that it was better in cases where we had, from the number of the lights in a building, to use more than one converter, to bank them—that is to say, connect all the primaries and all the secondaries in multiple, and distribute from this 'bus wire; but two or three peculiar experiences have led us to change our plans, and never to do so if it can be easily avoided. We had two or three unfortunate cases where one converter of a bank, for some unknown reason, would blow its plugs, thus overloading the others; then perhaps another would give way, and thereafter it was a race as to which would blow its plugs the quickest. It is not calculated to make one feel comfortable to have 400 lights in a theatre go out at once, just as the curtain is about four feet from the stage, in the beginning of the third act; yet this was our experience last Christmas Day. We had the converters fused up and running in half an hour, but next day the same thing occurred, though

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the gas-man, seeing the lights dim down, was quick enough in shutting off his different circuits to stop three or four converters, which gave him lights enough to pull through. We have cut this building up, and each converter now carries its own load, with the result of our detecting one of them, which, for some reason unknown, always tried to do more than its share of the work; but while we have marked it, we have not troubled to change it, as, working singly, it does its work well. We have had another case of the same kind in another bank of converters, which have also since been cut apart, when we found the trouble arose from a poor connection which heated up the fuse to melting point; yet, as we have in the city hall two banks of twelve 40-light converters each, and in the union station a bank of twenty-three 40-light converters and three 20-light converters, which have never had the current off them for nearly three months, and have never had a single converter of all these blow its fuses, we cannot say that this result would always or even generally obtain; but as the object of banking is primarily to prevent the total extinction in case of one converter going out, and this is better attained by the judicious running of the secondary circuits, we prefer keeping the converters separated.

For the secondary wiring in the buildings we need lay down no laws. The rules governing this are too well known to need any repetition. One advantage of the alternating system, which was first brought to my attention by one of our wire men, is the fact that wires carrying the alternating system do not blacken the surface on which they run. We have in our station circuits of direct and alternating currents side by side, put up at the same time on a ceiling painted in very light colours, and which have been burning the same number of hours. The paint under the direct-current wires is very dirty, in the usual style, and the wires themselves are covered with a black deposit; while the alternating-current wires, and the ceiling on which they lie, are as clean as the day when they were put up.

There yet remains one point on which I wish to say a few words, and it is a subject of the greatest importance. Now that the alternating-current distribution is a pronounced success, there is no reason why the places of all others where incandescent light is most desirable, namely, in residences, should not enjoy the advantages and improvements from which they have hitherto been debarred by their distance from the usual centre of distribution, and it is when we bring electricity into the dwelling house, where it will be daily and hourly needed and handled by women and children, that we realise how absolutely necessary it is that we use anything and everything which can tend to make safe its introduction and manipulation. Of course the first, second, and third of these are, good insulation, better insulation, and best insulation; but besides this there are other points to be considered, and one that seems to be worthy of very careful consideration, and the fullest discussion is that which has been more than once suggested, namely, the making of a permanent ground connection with the secondary wires. The object of this, of course, is that should a leak occur at any point between the primary and the secondary, the current, being already grounded, will render it impossible for anyone to receive a shock by touching the secondary, and at the same time making an earth connection. When I first considered this question I said in my haste that this was not a proper course of action, as one is simply provoking a ground at some other point, and seeing the careful insulation of the converters we use I could not see any danger of a leak across; but I have since made up my mind not to come to any conclusion at all until I have considered and heard some discussion both *pro* and *con.*, and for this purpose I should like to hear the most bitter partisans on either side, that we may get from them every little weakness on either side of the question brought out.

In a paper like this it is impossible to do more than to give the mere sketch of the subject, but I trust that what I have said may be the means of inviting discussion and inquiry, for it is only by this means that we can arrive at the true facts of any case, and, as we all know, the electric light industry has suffered more than tongue can tell from the general ignorance of its dangers and requirements, which hindered and injured its early introduction into this country, and which led to the spending of so much good money on plants and wires which were not merely insufficient, but absolutely dangerous.

Now that we have taken, as it were, a new departure, and entered upon a new era of progress, let us not fall into the same errors which marred the early history of our business, but strive with might and main, by discussion and interchange of experience, to make each new installation another stride towards perfection in what I think is undoubtedly the greatest achievement of the age—the distribution of electricity by alternate currents.

ELECTRIC LIGHT STEAM ENGINES BY RANSOMES, SIMS AND JEFFERIES.

We are glad to find that many of our engineering friends are already feeling the benefit of the improvement in trade. Messrs. Ransomes, Sims and Jefferies (Limited), of Ipswich, who are always well to the fore with any new machinery, are now supplying a very complete series of engines—both portable and stationary—specially suitable, amongst other purposes, for driving electric light machinery.

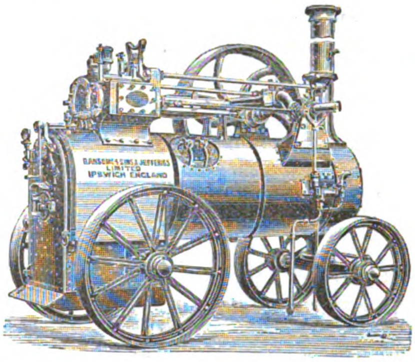

Fig. 1.—Compound Portable Engine.

The continuous necessity for engines which will economise fuel to the greatest possible extent has led to a large demand for "compound" engines, which, working at a high pressure, generate steam most economically, make use of its fullest expansive force, and thereby secure the largest amount of power for the fuel consumed. Fig. 1 shows one of Messrs. Ransome's compound portable steam engines, which are made from 8 to 20 horse-power nominal. The cylinders, which are placed side by side, are of the most suitable proportions to ensure steadiness in work. They are made with the outer shell and valve chests in one casting, the inner or working barrels, made of a special hard iron, being cast separately. The boilers are made of best quality mild steel plates, flanged and riveted by hydraulic machinery. They are proved to a high test pressure, and are capable of working continuously at 120lb. per square inch. The crank-shaft brackets, of wrought iron, are firmly riveted to the boiler, and also stayed to the cylinder by two strong wrought-iron tie-rods, thereby relieving the boiler of all strain.

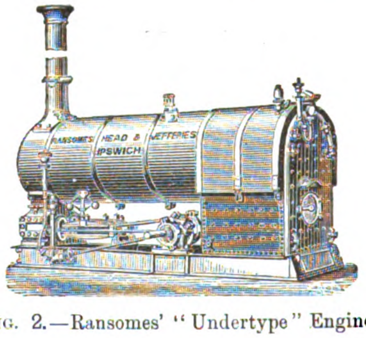

Fig. 2.—Ransomes' "Undertype" Engine.

In Fig. 2 we give an illustration of Messrs. Ransomes' "undertype" engine, in which the cylinder and working parts are placed on a strong, wrought-iron frame below the boiler. These engines are much in favour for electric light installations on account of their compact design—boiler and engine being self-contained—and the small outlay required for foundations. These engines are made on

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the simple or compound principle, and with special expansion gear for ensuring regularity in speed.

The third illustration represents a long-stroke stationary engine, for which Messrs. Ransomes have already had many orders. This engine has found also special favour abroad. It is of the Trunk-Girder type, with disc-crank, and when fitted with Messrs. Ransomes' patent automatic governor expansion gear makes one of the most economical and best finished engines we have ever seen.

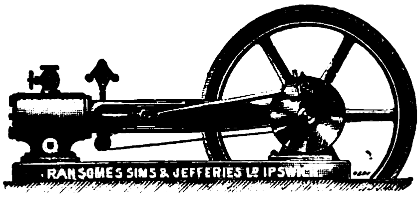

FIG. 3.—Long Stroke Stationary Engine.

Fig. 4 represents a compound stationary engine, the demand for which is steadily increasing, and of which Messrs. Ransomes have sent several of different powers to the Cape, India, &c. The entire engine-work is mounted on a strong wrought-iron frame, of channel section, which for shipment is taken to pieces so that the weight of the various packages may be reduced to almost any desired limit, a matter of extreme importance in countries where the inland carriage over bad and almost impassable roads is exceedingly costly, and next to impossible for large and heavy packages.

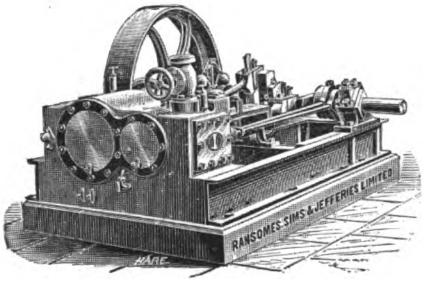

FIG. 4.—Compound Stationary Engine.

Steam is generally supplied by two separate boilers, arranged for a working pressure of not less than 120lbs. The two boilers, as a rule, are found more convenient than one larger boiler. They are made of mild steel plates throughout, and can be furnished for abroad with extra large fire boxes adapted for burning every description of inferior fuel. Each boiler is provided with a steam dome, and the connecting pipes between the boilers and the engine are entirely of wrought iron, giving lightness and strength. To each boiler is attached a suitable donkey pump. An injector is sometimes supplied in addition, giving thus, as an extra precaution, a double-feed arrangement. In some cases a separate surface heater is furnished, which raises the temperature of the feed water to boiling point, and is extremely useful in purifying the water when impregnated with lime or other foreign matter.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 10th*, 1888.

Interesting news comes from Washington with regard to the development of postal telegraph schemes. The Committee on Commerce of the House of Representatives has agreed to report favourably on the Bill, which creates a special bureau in the Post Office department. It is to be known as the Bureau of Postal Telegraphs, and is to be assigned to the care of a fourth assistant Postmaster-General. This functionary is to have trunk lines built wherever they may be wanted, and to employ the necessary staff. The rates fixed are 10 cents for twenty words for 500 miles, and proportionately larger for longer distances, 5 cents being charged for every additional ten words. The report which accompanies the Bill takes the shape of a long argument. The assertion that Congress has no power to pass such a measure is flatly denied, and, on the other hand, it is urged that public safety and convenience require the control of a telegraphic system by the Government. The report says in just so many words :—"Of all the monopolies, it is respectfully submitted that the telegraph system of the country, substantially owned and controlled by one man, is the worst and most dangerous;" and it is added, "The committee are still of opinion that the time has arrived when it is no longer safe or expedient to entrust to the hands of one overpowering monopoly the telegraphic business of this country. It is a power that not only can be used, but has been used, for purposes hostile to the best interests of the people." We are further told :—"The people are not in a mood to repose a trust of this character any longer without competition in the hands of a stock-jobbing corporation whose managers in the nature of things have not the slightest interest for the public good, but are alone concerned in the aggrandisement of their own fortunes." It will be seen that this measure contemplates the establishment of Government service in competition with and in opposition to the Western Union Telegraph Company. It may be very seriously doubted whether, even admitting the most serious charges and accusations against the Western Union Company to be true, Congress will vote for such a measure of confiscation. In abolishing evils that have had the recognition of the law, public opinion to-day, in all civilised countries, requires that there shall be some measure of compensation to those whose interests suffer, and where the question is one of this nature, upon which public opinion seems to be pretty evenly divided, it is utterly unlikely that any system of spoliation will be tolerated. In the meantime another Bill is reported from the United States Senate Committee on Post Offices with the object of controlling inter-State telegraphy. This Bill provides that it shall not be lawful to charge more for short-distance messages than for those transmitted longer distances in the same direction. A precedent for such a measure is to be found in the Inter-State Commerce Bill regulating railroad charges. Of the two Bills that I have mentioned above, that from the Senate stands by all odds the best chance of becoming law.

In our own State of New York the policy of interference thus in favour at the national capital is paralleled by the legislation based upon the recommendations of the committee which recently investigated the working of telephone companies. I sent you some account of this investigation at the time it was going on. The committee in their report arrive at the conclusion that the present telephone monopoly may be extended beyond the term of expiry of the present patents, by the taking out of other patents now in interference, and in other ways, and that the only remedy lies in the invention of a "make and break" system. That such an invention will be made appears to these gentlemen, upon expert advice, very uncertain. The committee also think that State Legislatures have no right or power to regulate the royalties charged by the parent company under its patents, but they hold that the charges made to subscribers by the local companies are liable to local restrictions. In their opinion there is but one circumstance which justifies legislative interference, and that is the levying of such charges as give local companies an undue return on their investment. This condition the committee consider to exist in only two cities in the State, viz., New York and Troy. In order to meet the case of New York, the committee present one Bill fixing the rate of subscription to be charged by the metropolitan company at $6.50 per month. At present it is $12.50. A second Bill provides that no stock shall be issued by local companies without an off-set in the shape of cash or securities. This measure is directly against the practice which has been followed by the parent company in accepting stock in part or whole payment for the local franchise. It will be seen that this is not a very sensational report; in fact, it confirms many of the arguments advanced by local companies, and goes to show that the stories of huge profits made by the local companies are almost wholly without foundation. Once more, too, the attempt to reach the parent company through State investigation and legislation fails of its purpose.

Speaking of the telephone reminds me that the Police Commissioners of New York have just made an important decision

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with regard to the system of police signalling to be adopted by the city. As I wrote you not long ago, several systems have been on trial for a number of months, and the test has been a very severe one. The contract has now been awarded to the Herzog Teleseme Company, who use a signal box, which, operating upon the district messenger system, will turn in 300 or 400 different calls, and is so constructed that in case of several calls being turned on simultaneously to head-quarters, they are stored up, so to speak, and can be taken off *seriatim* and at will. In this competition the telephone played a leading part, being included as a necessary feature in several of the systems; but the commissioners came to the conclusion that for such work the telephone was practically unavailable, its inherent defects being insurmountable. For instance, one of the necessities of the case was that there should be some registration of the message sent, in order to avoid disputes, and to furnish evidence which would often have to be forthcoming. This, of course, the telephone could not give. Another objection to the telephone was that it would very often have to be used in noisy places, along busy thoroughfares, under the elevated railroads, and in the midst of turbulent crowds; hence it would be impossible to get even a glimmer of an idea as to what the excited guardian of the peace wanted to say. Then, again, each telephone call as it came in would require immediate attention and reply; but this could not be given without employing a large, unwieldy and expensive staff at head-quarters. There were other points of objection, but these, probably, were the chief. It is understood that the work of installing the new system will be begun immediately, and that £20,000 will be spent, to begin with, in equipping several of the down town precincts. The desirability of having any system of intercommunication between the policeman on his beat and head-quarters is apparent, and in adopting this new system New York is setting an example that many other cities may be ready to follow. This teleseme system has also been applied to hotel service, for which it is obviously very well adapted, and for which, I believe, it was originally devised.

Unless other cities hurry up, New York will be the first in this country to have a regular line of storage street cars in operation. A very neat station is now being fitted up on the Fourth-avenue line for the service of ten storage cars, and the plant will be in operation in May. The ten cars have been ordered and are now being built. Good results may be expected, as the work is being done all round in excellent style, and is in charge of Mr. C. O. Mailloux, an electrical engineer of great ability. The track upon which the cars will run is by no means of the best, and the other conditions are, as many of your readers know, far more onerous than those to be dealt with in Europe; but as the cars will be of intelligent and consistent design for the work they have to do, and will not be an experimental collection of ill-assorted parts, reasonable hopes of success are entertained. The only wonder to me is that with the heterogeneous jumbles of machinery that we have had up to date any sort of success at all has been attained. It is about time that protests were made against assigning to electricity tasks which no other agency could cope with, and then giving it the worst possible mechanism for the performance.

This is a day of combinations in America, and, of course, electricity has its share. You are already fully informed as to the compact existing between the Thomson-Houston, the Westinghouse, the Consolidated, and the Sawyer-Man Companies with regard to lamp manufacture, and the use of the alternating system. The Mather Company now appears to have come within the terms of this arrangement, having announced that it will supply its customers with Sawyer-Man lamps. Not satisfied with its large share of the lighting business, the Thomson-Houston Company, which established no fewer than 150 local companies last year, and had recently entered into an alliance with the Bentley-Knight Electric Railway Company, is now, it is reported, still further strengthening itself in the motor field by joining hands with the Van Depoele Company. As the Overhead Conductor Railway Company, which is practically an off-shoot of the Westinghouse lighting system, is already understood to be in close relationship with one or more of the companies just mentioned, it will be seen that the whole makes a very strong combination. In fact, so many leading companies have not been acting in concert since the days of the old Gramme combination which went to pieces a few years ago, but which, had it been held together, would undoubtedly have controlled the whole of the electric lighting business to-day in America. It is natural that much interest should be taken in the present state of affairs, and that many conflicting reports should find their way into circulation. How far the above defines the actual situation it is not easy to say positively, but it is believed to range near the truth, and to be correct in outline.

With the opening of Spring, the work in the department of electric railroading outside the large cities begins again in earnest. The past week has seen two new roads go into operation—those at Carbondale, Pa., and Wilmington, Del., both using the Sprague system, with overhead conductors. It may be noted, too, that a very favourable expert report on the adoption of electric motors for the street railways of Washington has been made to the Commissioners of the District of Columbia.

NOTES FROM BERLIN.

(FROM OUR OWN CORRESPONDENT.)

The electric light is making extraordinarily rapid progress in this country. The following comparative statement showing the increase of installations in Berlin alone between March, 1886, and March, 1887, will give some idea of this progress; and it is believed that the rate has been well maintained during the last twelve months. The figures are the result of most careful inquiry, but it is of course impossible to guarantee perfect accuracy in a matter of this kind:—

	End of March, 1887.	End of March, 1886.	Increase.
Number of installations	333	152	181
,, of arc lamps	1,554	736	818
,, of glow lamps	22,363	12,705	9,568
,, of installations supplied by the central station of the Staedtischen Electricitätswerke	163	43	120
Worked by steam engines	124	79	45
Worked by gas engines	46	30	16

The twenty-six arc lamps in the Leipziger Strasse are not included in the above figures.

Taking each incandescent light to equal one gas flame, and each arc light to equal six gas flames, the above total number of lamps corresponds to about 31,687 gas lights, which is equal to about 4 per cent. of the total number of lights supplied by the Municipal Gas Works, and about 2½ per cent. of the whole number of gas lights in Berlin.

A large installation is in progress at Darmstadt. The cables, supplied by the firm of Siemens and Halske, are delivered; so also are the boilers, which are by Gohrig and Lemke. The whole installation is to be in working order by the 15th July. It will supply the Court Theatre, as well as a considerable number of houses in that district.

The regulations for the supply of the electric current by the Staedtischen Electricitätswerke at Hamburg have just been issued. The supply is compulsory from noon to sunrise daily. The customers are charged by meter, and have the option of purchasing or hiring meters at fixed prices. They also pay for their own glow lamps. There are very elaborate regulations and instructions as to the respective duties of the consumer, and the supplier in the event of a breakdown, either local or general. Current is supplied at the rate of 4 pfennige (equals ½d. nearly) per 50 watt-hours. This is at the rate of about 0·3d. per 10 candle-power glow lamp per hour, and for other sizes in the same proportion.

Arc lamps are charged at the rate of 1·38d. per hour for a lamp taking three amperes (say 300 candle-power), and for other sizes in the same proportion. The consumer has also to pay an annual charge of 5s. for each glow lamp, and 10s. for each arc lamp installed, whenever the daily average usage is less than 2½ hours. The municipal authorities reserve the right to revise this tariff list at the end of 12 months.

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CORRESPONDENCE.

SUBMARINE OCTUPLEX TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can you or your readers give me any information on the subject of the discovery mentioned by Mr. J. Henniker Heaton in his paper read last week before the Royal Colonial Institute ?

I refer to the invention that Mr. Heaton says has been brought forward "by which four messages can be transmitted each way at the same time along a single cable."

The question is one of some interest to me, as I was associated with the first practical application of duplex working on long cables, and as that system only gives one message each way at the same time, there is reason to fear that its days are numbered.

I have given close attention for some years to the subject of cable working, and I am surprised that not even a rumour of the new discovery should have reached me. In fact, until I read the report of Mr. Heaton's paper in *The Electrician* I was not aware that a single step had been taken towards the solution of the problem of the simultaneous transmission on long cables of even two messages in the same direction.

The discovery of a method by which four messages at once can be sent each way on such cables should bring fame and fortune to the inventor.

It is therefore somewhat surprising that, so far as I can learn, the system has not hitherto been brought to the notice of any of the existing submarine telegraph companies.

Can it be that the invention is not yet quite complete, and that those microfarads are giving trouble ?—Yours, &c.,

HERBERT TAYLOR.

4, Great Winchester-street, E.C., 21st March, 1888.

[We regret to say that we are unable to afford our correspondent any information upon the subject, the announcement contained in Mr. Henniker Heaton's paper being the first which has come to our knowledge. Possibly some of our correspondents may be able to give further information—or possibly it may be safe to treat the statement as a figment of the author's own imagination.—ED. *E.*]

ALTERNATE-CURRENT TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I noticed in your late issues a series of reports of the discussion on the above subject at the Society of Telegraph-Engineers and Electricians, which took place during my absence in America. Both Mr. Gordon and Mr. Crompton seem to be extremely doubtful of the possibilities of an alternating system, assuming certain details of working, on which the efficiency of the system must depend, to be impracticable. I allude to the coupling up of alternating machines in parallel and the use of small machines instead of large ones. My company having interests in this system of distribution of electricity I inspected several stations in the States equipped with complete Westinghouse plants. The practice in all of them was to use small dynamos, each dynamo running off a separate Westinghouse engine, the power being transmitted through a belt. They would have in the daytime a sufficient number of machines running to just supply the required current (thus obtaining a maximum efficiency of both engine and dynamo), and as the demand for current increases more machines are connected in parallel to the working system. The method of connecting in parallel has been brought to a simplicity that leaves nothing to be desired. The already working system and the fresh dynamo that is to be added to it are connected to two circuits on a small piece of apparatus showing by two lamps the difference of phase of the two currents. Each lamp varies from a maximum brilliancy to "black out" at a comparatively slow rate, and not coincidentally. The "beats" of the lamps alter in respect to each other, until in a few seconds the lamps go out and attain their maximum brilliancy at the same time. When this point is reached the switch is put up, and the machines are running in parallel without any disturbance taking place. Looking at the machine that is about to be switched on, the only evident sign at the moment of connection is a tightening of the belt from the load placed on it. One is bound to conclude, therefore, that the "bottom has been knocked out" of many of the arguments used in the course of the discussions above referred to, and that the consensus of opinion in this country in favour of distribution by means of transformers is fully justified and strengthened by what is being achieved daily in America.—Yours, &c.

E. MANVILLE.

Lambeth, S.E., 21st March, 1888.

STREET LIGHTING OF ENGLISH TOWNS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the letter of Mr. J. O. S. Elmore in your issue of 16th inst., to make your list of street lighting in English towns complete you must add Leamington, which, we believe, is the only instance in England of street lighting on the incandescent system in parallel. We have installed there 183 "Swan" 18 candle-power lamps. These are lighted during the ordinary hours of street lighting, and are paid for by the town at the same rate as their gas lamps, viz., £2. 2s per lamp per annum, including the lighting, extinguishing, cleaning, and renewing of the lamps. This works out at about 4d. per unit. The current is also supplied to the municipal and other public buildings, and to the residents and shopkeepers in the principal parts of the town, but in this case is charged for by meter, at a rate varying from 8d. to 4d. per unit, and is measured by our Mr. Hookham's patent electricity meter.—Yours, &c.,

CHAMBERLAIN AND HOOKHAM (LIMITED).
J. BROWN, Secretary.

Birmingham, March 21, 1888.

FIRE OFFICE RULES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: However great the differences of opinion existing between electric light contractors and fire office inspectors, the advent of two more sets of rules, in addition to those of the Phœnix Fire Insurance Office, will not tend to simplify matters.

It is to everyone's interest to reduce electric lighting to its simplest form—an object which will certainly not be forwarded by having various authorities all looking at the subject from their own point of view. The stage to which matters have come has more especially been brought under my notice by my having been asked to draw up a set of fire office rules for one of the larger fire insurance offices. The effect upon the public mind will hardly be reassuring when they have to choose between conflicting opinions, every one of which is said by its upholder to be the one and only way of carrying out electric light installations. Whilst one does not wish an approach to the "go-as-you-please" license given to gas engineers, one does not wish to fall into the opposite extreme of having to take useless precautions. I had hoped that the days of firms putting in second-class material and scamping their work were coming to an end, but the time for this seems likely to be still further prolonged if there are several standards of work.

Unless the Society of Telegraph-Engineers or the "Dynamicables" will take the matter up in a broad-spirited way, it would be as well to have a meeting of those interested, and for them to appoint a committee, consisting of representatives of the fire offices, electrical societies, consulting engineers, electric lighting firms, &c., to draw up a set of rules. The present Phœnix Fire Insurance Office Rules might be taken as a basis, and altered or added to so as to include any points considered advisable by the committee. Finally, let this one set of rules be acknowledged, as it probably would be, by the fire offices, electric societies, and profession generally as the standard by which work must be carried out.

It might be of advantage to have a committee of appeal for new and disputed points in installation work, and there also might be a definite list of risks made out for different classes

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of buildings, such as theatres, private houses, mills, &c., together with the class and description of insulation that would be passed for such risks, this probably varying with the different systems of lighting and the rate at which the building is insured.—Yours, &c., F. L. RAWSON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: "Electrical Contractor," in his letter of the 16th inst., puts the question of fire insurance rules in a very forcible manner.

I do not think there is the least doubt that if only electrical contractors as a body had been consulted they would have given a unanimous verdict against the issuing of fresh rules, or interfering with those that have so long held the field. These new rules are solely attributable to the unsuccessful attempt on the part of the Society of Telegraph-Engineers to obtain for themselves the credit of having originated the only recognised insurance rules in existence. If there is a clique who seem to have tardily discovered the fact that they have had no hand in the issuing of these rules, and have any objections to them, why do they not come forward and state these objections? If they did this I feel confident that the Phœnix Company would be only too glad to entertain any reasonable suggestions they might make in order to render their rules as perfect as possible. This issuing of fresh rules will create the utmost trouble and confusion, especially amongst good and first-rate firms, who will be cut out altogether by those who will take advantage of a multiplicity of rules to put up cheap and bad work, besides unnecessarily alarming the public, who will immediately take it for granted that if electricians cannot mutually agree how to put up installations there must be very considerable danger run in adopting the electric light.

In future, how are specifications to be drawn up for installations? which set of rules will be taken as a basis of the way in which the work is to be executed? Supposing a building is fitted with the electric light, and insured in several offices, each having its own set of rules, how will it be possible for the contractor to get his work passed by the various insurance inspectors if each is going upon his own lines? Hitherto where a case has arisen as above it has nearly always been sufficient to inform the other insurance offices that the installation had been put up in accordance with the Phœnix Fire Office rules and passed by Mr. Heaphy.

Now all this will be changed, and contractors will have a sorry time of it. Consulting electricians will also be powerless to better the situation, as they cannot hope to get rival promoters of rules to agree to any but their own.

This question is of such momentous importance to all electrical firms, that unless a combined movement be made, and that at once, to counteract this action, a blow will be struck at our industry from which we shall suffer long and severely.

As it seems to be a question that only concerns electrical contractors, and not telegraph engineers, professors, or other learned scientists, the former should at once take steps to bring forward their united opinions, and in so doing I hope there will be many who will share the views of

ANOTHER ELECTRICAL CONTRACTOR.

March 20th, 1888.

PROPOSED METHOD OF RENDERING RETARDATION OF PHASE VISIBLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been trying, as suggested by you in *The Electrician* of March 9, whether, when the vibrator of an induction coil is illuminated by a Geissler tube placed in the secondary circuit, the change of phase of the current in the secondary obtained by varying its coefficient of self-induction can be made large enough visibly to affect the position of apparent rest of the vibrator.

I find that the motion of the vibrator can be magnified quite sufficiently for the purposes of private experiment by attaching to it a stiff straw whose direction is a prolongation of the spring, and that if the Geissler tube and a paper scale be placed immediately behind the straw the position of rest which it seems to take up can be determined with considerable accuracy.

In the secondary circuit I introduced the secondary of a much larger coil, whose primary remained open and whose core was adjustable and could be removed altogether. I found, however, that no perceptible difference in the position of the straw resulted either from the motion or removal of the core, or even from the short-circuiting of the coil itself.

The reason for this is not far to seek. It is, of course, impossible to speak of the resistance of a Geissler tube, but we may, for our purpose, suppose it replaced by a variable resistance. The smallest value of this resistance will, however, be extremely large, so large that with a moderate speed of interruption no perceptible difference of phase will be produced by the addition of the largest practicably attainable amount of self induction.

I have not yet found a satisfactory method of magnifying the motion of a Spottiswoode's rapid break, which I should like to substitute for the vibrator. I am afraid, however, that even if the experiment in that form could be carried out in the laboratory it would hardly be possible to adapt it to the requirements of the lecture room.—Yours, &c.,

L. R. WILBERFORCE.

Cavendish Laboratory, Cambridge, March 17, 1888.

RED VARNISH FOR INCANDESCENT LAMPS FOR A PHOTOGRAPHIC "DARK ROOM."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If I remember rightly there was given in *The Electrician* some time back a receipt for making a red varnish for incandescent lamps. I want to use one in a photographic dark room, and should be much obliged if you or any of your readers could tell me the quantities of the different ingredients that would be required to make a varnish of the necessary darkness. I have not got the back numbers of *The Electrician* out here.—Yours, &c., J. E.

Mexico, February 23rd, 1888.

[A correspondent who is an authority upon the subject of photography, and to whom we have submitted the above letter, has kindly written as follows:—

"I have much pleasure in telling you what I know about the matter. If your correspondent wants to set up a photographic dark room, he presumably has some negative varnish, and if so he has only to stain a little of it with 'fuchsine' to make a red varnish suitable to the purpose. The question of how deep the stain must be depends on several considerations, as the colour of the carbon when incandescent and the nature of the work to be done in the dark room.

"In connection with this point a most interesting inquiry presents itself, namely, to what extent is it worth while to varnish the lamp at all, seeing that almost any amount of *red*ness can be obtained by simply lessening the current passed through the carbon? What, in short, do you gain by raising the carbon to a state of high incandescence, and then cutting off the actomic rays by a red screen? Whether the lowest or '*red*-hot' stage of incandescence would be a safe light for modern photographic plates without any further protection is a question I cannot answer offhand, but I am sure that a '*red*-hot' lamp would only require a slight tinge of red in the varnish to render it safe, whereas if the incandescence is pushed, say, to three watts per candle, a very deep stain would be required which would cut off all, or nearly all, the light gained by the extra heat of the carbon."]

THE STABILITY OF OVERHEAD WIRES.

We have received a further letter of considerable length from Mr. Caws, but we think that it is now quite time to close this discussion, and therefore we merely give the latter part, which is as follows:—

"I remember calculating a year or two ago for an iron wire of 100 yards span *the dip which would remain constant for all*

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temperatures. It was not very different from the dip in common use as given by Brough's tables.

"At the constant dip of a catenary, the expansion and elasticity, being exactly equal and opposite forces, continually neutralise each other at all temperatures.

"But for copper catenaries the constant dip cannot be well employed in outdoor practice, for owing to the coefficient of expansion for copper being 50 per cent. greater than for iron—though the elastic modulus for iron is 50 per cent. greater than for copper—the tension of a copper wire at which the elasticity and expansion neutralise each other is too severe to leave enough reserve strength to meet storms and extra strains generally. Hence the necessity of spring shackles for copper lines.

"Those old books to which Mr. Preece has now referred me are very useful, but not to the point at issue. I have much pleasure, however, in inviting Mr. Preece's attention to a new paper dealing specially with the question theoretically and experimentally, viz., '*Conditions d'equilibre d'un Fil de Bronze Phosphoreux tendu entre deux appuis.*'

"The very able author, M. Cloeren, of Brussels, has kindly sent me a copy, accompanied by an expression of his satisfaction at the Monkwearmouth experiments.

"When Mr. Bozon seriously 'corrected' me for leaving the weight of my dynamometric apparatus to bear on its own proper side of the scale, and for not confounding it with the span which constituted the weight on the other side of the scale, I could not help laughing at such a 'bull.' But I had not the faintest intention of being 'personal,' and if my jocular observation wounded his *amour propre* I ask Mr. Bozon to let them pass; for it is well known that the cleverest of men are sometimes notorious for making 'bulls' of the most laughable character.

"On page 504 *The Electrician*, October 21, 1887, Mr. Bozon will find the question of chafing discussed, and the way to prevent it pointed out."

A LINESMAN'S LAMENT.

TO THE EDITOR OF THE ELECTRICIAN.

Ere winter, Sir, you had your fling
  At them there monkeys yonder,
Who on the wires for pastime swing,
  And break 'em down like thonder.

Well, nigger monkeys may be bad,
  Most gymnerasteric things, Sir,
And Brazil linesmen may be glad
  To get them Caws's springs, Sir.

But homebred snowflakes let me back
  Agin all monkeys goin';
They're white, 'tis true, but then, alack!
  The De'il is wi' them blowin'.

They drop by millions on the spans,
  Soft footeder than Fancy,
And who among us unnerstan's
  Their wicked dill-y-dancy?

So fast it falls, so close it clings,
  That in a magic trice, Sir,
These flyin' monkeys fold their wings,
  And there's your rope of ice, Sir!

Than all the tropic monkey kind,
  In spite their summer trainin',
This frigid imp of snow and wind
  Is mischiever at strainin'.

Them springs will hold till all is blue,
  Wi' snow and wind together,
Yet "gie the verra De'il his due,"
  By humourin' his tether.

By civil dodgin' to and fro,
  They'll mischief circumvent, Sir;
Then, let the blastin' Blizzards blow!
  And give the Furies vent, Sir!

If you could see this ruined line!
  Not half on't mended yet, Sir;
You'd surely make these lines of mine
  Your nextest leaderette, Sir.

North Britain, March 16, 1888. DANIEL WALKER.

PHYSICAL SOCIETY.

At the meeting of this society, held on the 10th inst., the first paper was read by Mr. G. L. Addenbrooke

"ON A PORTABLE REFLECTING GALVANOMETER."

(This paper we reproduced in our last.)

Mr. E. C. RIMINGTON then read a paper on

"The Measurement of the Power Supplied to the Primary Coil of a Transformer,"

This method gives a means of measuring the power supplied to the primary by one reading of a high-resistance Siemens dynamometer without knowing either the resistance or coefficient of self-induction of the primary. The arrangement employed is shown below:—

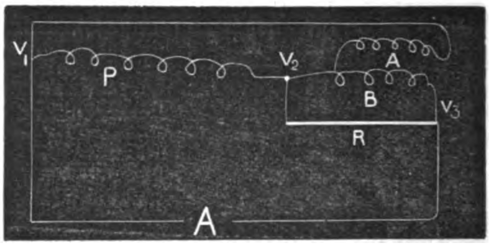

FIG. 1.

P is the primary coil, R a non-inductive resistance, A alternating-current dynamo, V_1, V_2, V_3 potentials at the ends of the primary coil, and the resistance R. A and B coils of a high-resistance Siemens electro dynamometer.

Let r_1 and L_1 be the resistance and coefficient of self-induction of the coil A, r_2 and L_2 those of the coil B. Let s_1 and s_2 be the impedances of the coils A and B respectively, i_1 and i_2 the currents in them, and ϕ_1 and ϕ_2 their angles of lag; let ϕ be the angle of lag of the primary coil. Let δ be the reading on the dynamometer, and k some constant.

Let $$\frac{L_1}{r_1} = \frac{L_2}{r_2}.$$

Now $$\tan \phi_1 = \frac{a L_1}{r_1} = \frac{a L_2}{r_2} = \tan \phi_2;$$

$\therefore \phi_1 = \phi_2$; where $a = \frac{2\pi}{T}$, T being the periodic time.

Let E_1 and E_2 be the maximum values of the potential differences between V_1 and V_2 and V_2 and V_3 respectively.

Then, $$\delta = \frac{k}{T} \cdot \frac{E_1 E_2}{s_1 s_2} \int_0^T \sin(a t - \phi_1) \sin(a t - \phi - \phi_2)\, d t$$

$$= \frac{k}{2} \cdot \frac{E_1 E_2}{s_1 s_2} \cos(\phi_1 - \phi_2 - \phi) = \frac{k}{2} \cdot \frac{E_1 E_2}{s_1 s_2} \cos \phi.$$

Now the power supplied to the primary coil or

$$p = \frac{E_1 E_2}{2 R} \cos \phi = \frac{\delta}{k} \cdot \frac{s_1 s_2}{R}.$$

If $\frac{K}{R}$ is the constant of the dynamometer for watts with a steady current

$$k = \frac{r_1 r_2}{K}$$

$$p = \frac{K}{R} \delta \frac{s_1 s_2}{r_1 r_2}.$$

But $$s_1 = r_1 \sqrt{1 + \frac{a^2 L_1^2}{r_1^2}} = r_1 \sqrt{1 + \tan^2 \phi_1},$$

and $$s_2 = r_2 \sqrt{1 + \tan^2 \phi_2}.$$

Hence $$p = \frac{K}{R} \cdot \delta \cdot (1 + \tan^2 \phi_1),$$

where $$\tan \phi_1 = \frac{a L_1}{r_1} = \frac{a L_2}{r_2}.$$

L_1 and L_2 can be found by any of the well-known methods of determining coefficients of self-induction, and r_1 and r_2 adjusted so as to satisfy the above condition by putting non-inductive resistances in series with the dynamometer coils. By making r_2 the movable coil and giving it a value considerably less than r_1, R may be made in the same proportion less than the impedance of the primary coil P, thus avoiding the waste of much power in R.

Prof. AYRTON considered the method very inferior to the one described by him at the Society of Telegraph-Engineers, and illustrated in *The Electrician* of Feb. 24, as Mr. Rimington's method,

while open to the same objection as the one due to himself and Prof. Perry, of wasting power by the introduction of resistance in series with the primary, presupposes in addition the rate of alternation to be known.

It was unnecessary to use Joubert's method to determine the coefficient of self-induction of the primary circuit, as the effective coefficient of self-induction was at once calculated for each of the experiments by the following formula :—

$$L = \frac{r}{\pi} \sqrt{\frac{\overline{V}^2}{\overline{A}^2} - r^2}.$$

Where $\overline{A}$ and $\overline{V}$ are the square root of mean squares of amperes and volts respectively, given in columns headed *b* and *a* in *Electrician* of Feb. 24, p. 421.

The Professor stated that the formula $d = k\,(A - B)\left(C - \frac{A+B}{2}\right)$ (*Electrician*, Vol. XX., p. 420) suggested to Mr. Sayers, one of his former students, a method of constructing a direct-reading wattmeter for alternate currents, for by making C large in comparison with A and B, $\frac{A+B}{2}$ becomes negligible in comparison with C. Now if the quadrants of the electrometer be connected respectively with the two ends of the non-inductive resistance *r* (Fig. 2, *Electrician*, p. 420), instead of with A and B, and if the needle be connected with the other end of the primary coil of the transformer; in other words, if R and *r* change places, C will in practice differ from A and B by some 2,000 volts or more; hence we have

$$\frac{d}{k\,r} = \frac{A - B}{r}\,C,$$

and the power given to the primary circuit is at once obtained from the reading of the electrometer.

He considered a great desideratum at present was a method of measuring directly the power given to any circuit possessing self or mutual induction, or both, and traversed by an alternating current which was any function (not necessarily a sine function) of the term without requiring the introduction, in series, of a resistance, and without requiring a knowledge of the rate of alternation.

Mr. T. H. BLAKESLEY stated that he had devised such a method. The arrangement used by him is shown in Fig. 2.

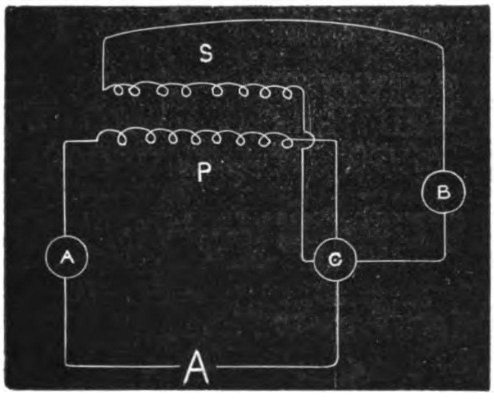

FIG. 2.

Let *m* be the number of coils in the primary, and *n* the number in the secondary.

Let α, β, γ be the readings of the three dynamometers respectively, and A, B, C their constants.

Let r_1 and r_2 be the resistances of the primary and secondary circuits respectively.

Then he finds that the total power supplied is given by the formula

$$A\,\alpha\,r_1 + r_2\,\frac{m}{n}\,C\,\gamma,$$

and the loss of power due to hysteresis by

$$r_2\left(\frac{m}{n}\,C\,\gamma - B\,\beta\right).$$

In reply to a question by Prof. Ayrton, Mr. BLAKESLEY stated that in obtaining these formulæ he recognises the existence of an angle of lag, but he makes no assumption with regard to the constancy of the coefficient of self-induction. The formulæ were obtained by geometrical reasoning, without the use of differential equations.

Mr. SUMPNER pointed out that the geometrical method of Mr. Blakesley involved the assumption that the electromotive forces and currents were all sine functions of the time, and that this assumption was erroneous unless the coefficient of self-induction could be considered constant. The angle of lag was subject to the same kind of variation as the coefficient of self-induction. He (Mr. Sumpner) hoped soon to bring to the notice of the society experimental evidence to show that the coefficient not only varied with the magnetising current and with the previous history of magnetisation, but that it always had two distinct values, according to the direction in which the current was about to be changed.

Mr. RIMINGTON, in reply, considered that an objection to Prof. Ayrton's method lay in the fact that electrometer deflections are usually small. He was of opinion that it was not a valid objection to his method that it presupposed a knowledge of the rate of alternation, as in most cases which occur in practice this can be determined.

Prof. PERRY then read an abstract of a paper by Prof. Ayrton and himself

"On the Magnetic Circuit in Dynamo Machines."

The authors have worked out a number of formulæ for dynamos, involving, not the number of coils on the armature, but the thickness *t* of the winding and *a*, the highest permanent current in amperes per square centimetre of the cross-section in that winding. All the numbers given in the formulæ, with the exception, of course, of volts, amperes, and watts, are in C.-G.-S. units. One of these is

$$W = \frac{2\,v\,N\,t\,a}{10^8} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where

W = highest permanent power or output developed,
v = circumferential velocity in centimetres per second,
N = total highest permanent magnetic induction through armature.

Then as the armature winding is thin $t\,a^2 = q^2$, a constant. In the case of some armatures which are always cool the value of q is about 150, but in the best modern machines its value is generally about 288. In some machines it is considerably over 300, but there is then undue heating. For fine wire the value of q is less.

The output can now be expressed in various useful ways; for example,

$$W = \frac{2\,q}{10^8}\,v\,N\,\sqrt{t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The value of N is given by

$$N = \frac{\frac{4\pi}{10}\,S'\,A'}{\frac{2\,(d+t)}{a_2} + \Sigma\,\frac{l\,\nu}{a\,\mu}} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

S′ A′ being ampere turns on one magnetic field-magnet circuit, d the clearance between the armature-winding and the pole-piece, a_2 the area of the pole-piece exposed to the armature (increased by a fringe all round of breadth 0·8 $(d+t)$), a the cross section of any iron part of the magnetic circuit of length l, through which there is an induction, ν N, the magnetic permeability being μ. From this it follows that W is a maximum when

$$\frac{2\,t}{a_2} = \frac{2\,d}{a_2} + \Sigma\,\frac{l\,\nu}{a\,\mu}\,;$$

that is, when the magnetic resistance of the space occupied by the winding on the armature is equal to the sum of the other magnetic resistances of the circuit.

The value of this rule is very great. For example, we have

$$W' = \frac{2\,\pi\,q}{10^9}\,\frac{v\,a_2}{\sqrt{t}}\,S'\,A' \quad . \quad . \quad . \quad . \quad . \quad (13)$$

The authors, after giving Frölich's and other formulæ for the law connecting N and S′ A′—that is, "the characteristic of the dynamo"—state that they had wasted much time in trying to obtain a simple formula, the constants of which could be calculated from the dimensions of the component parts of a machine. While giving all credit to the Drs. Hopkinson for their valuable study of the dynamo, they point out that Messrs. Hopkinson had not been able to calculate the characteristic for an existing dynamo with what could be called accuracy, and that for all practical purposes the following rule, based on (12), is sufficiently accurate :—

1. For values of N equal to more than half the maximum value, it is only necessary to study the air resistance, and write,

$$N = \frac{\frac{4\pi}{10}\,S'\,A'}{\frac{2\,(d+t)}{a_2}}$$

Let the straight line given by this be drawn upon squared paper.

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2. The maximum permanent value of N is $\alpha_1 \beta_1$, where α_1 is the diametral section of iron in the armature, and β_1 is a maximum permanent induction whose value in good machines ranges between 17,000 and 18,000.

Find the value of S′ A′ from the formula—

$$N = \frac{\frac{4\pi}{10} S' A'}{\frac{4t}{a_2}}$$

and plot these values of N and s′ A′ as rectangular co-ordinates of a point on squared paper.

Any one who has been accustomed to draw characteristics of dynamo machines will be able to draw a curve through this point, touching the straight line, which will not differ materially from the characteristic of the constructed machine.

In testing this rule on the Manchester dynamo the authors were afraid to trust to their judgment, as the real characteristic was already known to them.

They therefore assumed a curve

$$N = p \tan^{-1} (k \, . \, S' A'),$$

and determined it by the conditions that it should be tangential to the given straight line, and should pass through the given point, and the curve so obtained is shown in the original paper, drawn on the same sheet of paper with the curve calculated by Dr. Hopkinson, and the one obtained from the observations.

They state that in the best modern machines for incandescent lighting, the only place in which "throttling" of the induction is allowable is in the armature; but the usual rule now is to have β constant everywhere, that is to have no throttling anywhere.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

STUDENTS' MEETING.

A students' meeting was held on Friday last, the 16th inst., Mr. W. M. Mordey presiding.

Mr. Mordey made some remarks in regard to arbitrary units, and explained the system adopted by the Anglo-American Brush Electric Light Corporation for numbering wires and leads.

Mr. A. H. Dykes then opened a discussion upon transformers, which was continued by Messrs. Smith, Lamb, Cooper, Tidd, Collis, Zingler and Mordey.

The meeting then terminated after passing a vote of thanks to the Chairman.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

15,878A. VICTOR POPP. London. New or improved apparatus for measuring the time during which a current of electricity or other fluid is flowing. November 18, 1887. (Note.—This application having been originally included in No. 15,878, dated November 18, 1887, takes under Patents Rule 23 that date.)

3,672. H. EDMUNDS. London. Means or appliances for use in connection with electric circuits or water or gas supplies or the like, to enable a supply of electricity for lighting or other purposes, or a supply of water or gas, or the like, to be obtained on the deposit of an equivalent therefor in the shape of prepayment or otherwise. March 9, 1888.

3,678. W. G. OLPHERTS. London. Improvements in and relating to electrical signalling or railways and in apparatus therefor. March 9, 1888.

3,685. S. SHARP, J. M. V. MONEY-KENT and H. J. PAYNE. London. Improvements in electrical switches. March 9, 1888.

3,690. E. DUNN. Forebridge, Improvements in railway electrical signalling apparatus. March 10, 1888.

3,710. J. TWEEDALE. Glasgow. Improvements in electro-magnetic motors. March 10, 1888.

3,714. A. C. COCKBURN and F. DAY. London. Improvements in electrical fittings. March 10, 1888.

3,740. A. BERNSTEIN. London. An improved combined cut-out and switch. March 10, 1888.

3,812. E. L. BERRY and G. FRANKE. London. An improved combined switch and holder for electrical incandescent or glow lamps. March 12, 1888.

3,835. H. P. COPELAND. Manchester. Improvements in telegraphic apparatus. March 13, 1888.

3,883. A. J. BOULT. London. Improvements in electrical devices for type writers (J. F. McLaughlin, United States). March 13, 1888.

3,921. T. PARKER, E. SCOTT, G. REES, and J. H. WOODWARD. Manchester. Improvements in apparatus for indicating, measuring and controlling electrical currents. March 14, 1888.

3,929. T. PARKER, E. SCOTT, G. REES, and J. H. WOODWARD. Manchester. Improvements in and relating to dynamo-electric machines. March 14, 1888.

3,968. J. W. KING. London. Regulation of feed of arc lamps. March 14, 1888.

3,979. W. G. JOHNSON. London. Improved construction of plates and arrangement of fastenings for connecting them in voltaic order for medico-electric purposes. March 14, 1888.

3,981. E. HOPKINSON. London. Improvements in and connected with means for driving, controlling, and working electrically propelled vehicles, cranes, and the like. March 14, 1888.

3,986. B. M. DRAKE and J. M. GORHAM. London. An improvement in plates for secondary voltaic batteries. March 14, 1888.

3,995. H. H. LAKE. London. Improvements in and relating to galvanic batteries (H. Walter, United States). March 15, 1888.

3,993. T. C. R. HORSFIELD and R. PORTER. London. An improved electrical indicator for the locking apparatus connected with railway points. March 15, 1888.

4,008. H. ULLATHORNE and C. GAUZENTES. Bradford. Improvements in electric batteries. March 15, 1888.

4,107. G. E. DORMAN. Stafford. Improvements in electric arc lamps. March 15, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

March 17, 1888.

16,273. E. DESROZIERS. London. Improvements in dynamo-electric machinery. December 11, 1886.

4,545. C. D. ABEL. London. Improvements in electrical measuring and indicating apparatus (the firm of Siemens and Halske, Germany). March 26, 1887.

4,714. F. A. AMORIC. London. Improved electrical signal bell apparatus for stations communicating with a single-wire telegraphic circuit. March 29, 1887.

5,186. A. P. TROTTER and W. T. GOOLDEN. London. Improvements in brush holders for dynamo-electric machines. April 7, 1887.

5,210. A. SERRAILLIER. London. Improvements in automatic apparatus for subjecting the person to the action of electric currents. April 7, 1887.

6,409. R. E. B. CROMPTON and W. A. KYLE. London. Improvements in dynamo-electric machines and motors. May 2, 1887.

6,681. R. E. B. CROMPTON (Chelmsford) and J. C. HOWELL (Llanelly). Improvements in secondary batteries or electrical accumulators. May 6, 1887.

7,317. J. KYNOCH and W. HABGOOD. London. Improvements in secondary electric batteries. May 19, 1887.

8,262. W. M. MORDEY. London. Improvements in and pertaining to electric generators. June 8, 1887.

PATENTS SEALED.

March 9, 1888.

15,344. A. M. CLARK. London. Automatic switch and governor for electric lighting purposes. (The Electro-technische Fabrik Cannstatt, Germany.) November 24, 1886.

16,865. L. R. DAVIES and M. SHEARER. London. Improvements in coupling up batteries for lighting and other purposes. December 23, 1886.

15,099. A. LE NEVE FOSTER and W. S. STEGGES. London. Improvements in the transmitting and receiving apparatus of type-printing telegraphs. November 5, 1887.

16,424. W. P. THOMPSON. Liverpool. Improvements in telegraphic instruments. (C. G. Burke, United States.) November 29, 1887.

16,476. W. BAYLISS and E. JONES. Wolverhampton. An improved manufacture of riveted galvanised telegraph and telephone poles. November 30, 1887.

March 16, 1888.

1,664. W. KINGSLAND. London. An improved method of closing or sealing secondary battery cells. February 2, 1887.

2,851. T. PARKER. Wolverhampton. A new or improved automatic switch or cut-out for electrical circuits. February 24, 1887.

3,197. S. D. L. SALOMONS, Tunbridge Wells, and T. PARKER and P. B. ELWELL. Wolverhampton. An improved means of separating the plates in secondary batteries. March 2, 1887.

3,469. C. A. McEVOY. London. Improvements in electric primers and mechanism for firing breechloading guns. March 7, 1887.

4,478. C. MAYNARD. London. Improvements in the mode of and means for supporting or carrying telegraph or telephone wires or lines. March 25, 1887.

11,448. J. S. SELLON. London. Improvements in secondary batteries or electrical accumulators. August 22, 1887.

16,669. M. BAILEY and J. WARNER. London. An improved secondary battery combined with a miner's lamp. December 3, 1887.

16,728. A. HEINTZ. London. Improvements in the manufacture of incandescent electric lamps. December 5, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

2,819, 1887.—H. NERLINGER. Electric lamps. (Price 8d.)

2,825, 1887.—J. G. STATTER. Dynamo-electric machines. (Price 11d.)

4,549, 1887.—A. FEATHERSTONHAUGH. Electric incandescent lamps. (Price 4d.)

5,199, 1887.—W. LOWRIE and C. J. HALL. Distributing electric energy for locomotion. (Price 8d.)

5,303, 1887.—H. W. RAVENSHAW and others. Dynamo-electric machines. (Price 8d.)

5,505, 1887.—H. W. RAVENSHAW and others. Dynamo electric machines. (Price 8d.)

5,637, 1887.—A. SIEMENS and E. F. H. H. LAUCKERT. Electrical controlling apparatus. (Price 8d.)

5,833, 1887.—F. W. CROSSLEY. Combined gas motor engine and dynamo-electric machine. (Price 6d.)

6,177, 1887.—A. MARCILHACY. Adapting electric lamps to divers' helmets. (Price 8d.)

14,202, 1887.—J. R. HARD and T. WILSON. Medico-electrical apparatus. (Price 8d.)

1,078, 1888.—S. BERGMANN and J. T. DEMPSTER. Switches for electrical circuits. (Price 8d.)

LEGAL INTELLIGENCE.

The United Telephone Company v. The Equitable Telephone Company.

A motion for an injunction on behalf of the United Telephone Company was made on Friday morning last, before Mr. Justice Chitty, to restrain the Equitable Telephone Company from infringing the patents for telephones of the plaintiff company. The United Telephone Company being proprietors of the patents for telephones in which carbon is used, have established their right in the patent in the course of several actions, and the instruments are in general use rented from the plaintiff company. The defendant company was registered with a small capital in December, 1886, for the manufacture and sale of telephones, but they wrote to the plaintiff company stating their intention to manufacture and sell the article, which they invited the plaintiffs to inspect at the offices of the company, where it was fitted up. The plaintiffs took no notice of the letter. In December, 1887, and February, 1888, when the plaintiffs found the company was at work, they bought two of the instruments alleged by the defendants to be made according to their patent, and asserted by the plaintiffs to be an infringement of their patent. It was this instrument which it was sought to restrain the manufacture and sale of, and which it was said the defendants were endeavouring to force the plaintiffs to bring another action to try over again the validity of, notwithstanding the judgments already given in its favour. The defendants opposed the present motion on the ground of delay, arguing that as they knew in 1886 what the defendants were doing they ought to have come to the Court sooner. By an affidavit of the manager of the plaintiff company it was sworn that they did not take steps against defendants because it was thought the defendant company was a bubble company, and that the notice was only a threat, but as soon as they found the company was in active operation they brought this action. Mr. Justice Chitty said the plaintiffs were entitled to the injunction they sought, and that there had not been delay on their part. Undertakings in damages were given by both the plaintiffs and defendants.

COMPANIES' MEETINGS & REPORTS.

The German Union Telegraph and Trust Company (Limited).

The seventeenth ordinary general meeting of the shareholders of the German Union Telegraph and Trust Company (Limited) was held at the offices, Winchester House, 50, Old Broad-street, last Monday, under the presidency of Sir James Anderson.

The SECRETARY (Mr. W. Payton) read the notice convening the meeting and the minutes of the ordinary and extraordinary general meetings, hold respectively on the 21st March and 28th November, 1887. The minutes having been approved and signed as correct,

The CHAIRMAN said: When I last addressed you, I told you all that was to be said about the offer of the German Government for the purchase of our cables, and we were authorised to negotiate and carry out the terms of that offer. Notwithstanding what we considered a somewhat favourable offer, there was still a large margin of reserve about which we thought we should like to know more as to its distribution. Having that idea in view, your solicitor, Mr. Burt, your secretary, Mr. Payton, and myself went to Berlin last month, believing that we might possibly be forwarding the shareholders' interests by getting a portion of that reserve for the Company. There was a large sum of about £25,000, but there were important agreements which had to be made, some of them extending over a period of 11 or 12 years, and, naturally, those who had those agreements would have liked to get all they possibly could claim. We, however, thought we might give what was perfectly equitable and fair, and still obtain something out of that large sum for our shareholders. I am happy to say that we succeeded in that—not, of course, without some little warmth and discussion; but we parted good friends with the other side, and we are, we believe, about £10,000 richer than we were before we left here on that mission. We also agreed about the rent of our office at Berlin, the expenses of liquidation, the stamps, and, in fact, about every item that your solicitor or secretary could think of as likely to dip into this reserve; and we can therefore say with some accuracy that we think, if all goes well, we shall pay you within 1s. or 1s. 6d. of par. That will depend naturally on the expenses of repairs and breakages that may happen between now and next year. Our cable is broken just now, and the steamer "Britannia" is on the spot waiting for two or three fine days to effect the repair, which no doubt will be easily done. I do not think I have much more to say. We parted from our Berlin colleagues good friends, and I hope we shall not have to visit that city again on a similar errand. You will get your dividend to-day of 8s. 3d., and there will be no more dividends until next January, when you will, I believe, get three-fourths of your capital back, and the final distribution of capital will be in April. There is a meeting to be held in Berlin on the 27th inst., a final meeting to arrange all about the liquidation and pass the necessary resolutions, but as we were all agreed the other day when we were at Berlin, I hope we shall not have to go there again, but that it should be sufficient that our interests should be represented by our friends there by power of attorney. This is, perhaps, the last meeting but one of the German Union Telegraph and Trust Company. I am very sorry that it is to be wound up, because it is going on very well, but as the Government would not have a private company working the traffic, we had to put up with that decision. It is now my duty to move:—

"*That the report and accounts for the year ended 31st December, 1887, submitted to this meeting be and they are hereby received and adopted, and that a dividend of 8s. 3d. per share be declared payable this day free of income-tax, making, with the previous distribution of 5s. 9d., a total dividend for the year of 14s., or at the rate of £7 per cent. per annum.*"

That is compared with 6 per cent. last year.

Mr. H. G. ERICHSEN seconded the resolution.

The CHAIRMAN: If there are any remarks I shall be glad to answer and questions.

A SHAREHOLDER said he supposed the last dividend would be up to the 31st December, 1888, and that they would get no payment after that.

The CHAIRMAN: This is the last dividend. You will get your return of capital, which will include the dividend, whatever it is, in January and April.

The CHAIRMAN then put the motion in the usual way and declared it carried unanimously. He next proposed the re-election as a Director of Mr. Erichsen.

Mr. LOEWENTHAL seconded the motion.

The CHAIRMAN put the resolution, and it was carried unanimously.

Mr. LOEWENTHAL proposed the re-appointment of Mr. Henry Dever as auditor for the current year, at a remuneration of £25.

The CHAIRMAN put the motion in the usual way, and, having declared it carried unanimously, observed that that was the whole of the business.

Mr. WELLS proposed a vote of thanks to the Chairman and Directors, and said he thought they ought also to thank the Solicitor and the Secretary. Those gentlemen went to Berlin the other day in very inclement weather, and they appeared to have made a most satisfactory arrangement for the Company, by which the shareholders would get a larger sum than they anticipated when the purchase was made by the Government.

Mr. LOEWENTHAL seconded the motion, which was carried unanimously.

The CHAIRMAN: We are much obliged to you, gentlemen. It was not at all an agreeable task we undertook in going to Berlin. We knew that we were going to have something of a combat, and I think all ended very well.

Mr. LOEWENTHAL: The only regret we have is to part with you.

The SOLICITOR: That is a mutual feeling.

The proceedings then terminated.

The Direct Spanish Telegraph Company (Limited).

Report of the Directors for the half year ended 31st December, 1887, to be presented at the general meeting of shareholders, to be held at Winchester House, on Monday, the 26th inst., at twelve o'clock:—

1. The accounts for the half year ended 31st December, 1887, show, after providing for debenture interest and the balance of the charge for

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renewal of the shore-end of the cable at Marseilles, a balance to the credit of profit and loss of £5,564. 9s. 10d.

2. The traffic receipts are in excess of those for any half year since the formation of the Company, and show an increase of £1,338. 12s. 10d., as compared with the corresponding half year of 1886.

3. This increase of traffic has necessitated only a moderate amount of additional expenditure.

4. The Company's cables, and the land lines in connection with them, have continued in good working order throughout the half-year.

5. The Spanish Government Telegraph Administration, recognising the importance of the cable communication between Spain and England, has erected a new wire, of the most improved type, between Bilbao and Madrid, to be used exclusively for the cable work of this Company, and this will, no doubt, beneficially affect the traffic.

6. After putting £2,500 of the balance of profit and loss to the reserve fund, which now amounts to £8,447. 19s. 1d., there remains £3,064. 9s. 10d. available for dividends. The Directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend of 2¾ per cent. (free of income-tax) for the half year upon the ordinary shares, making, with the previous distribution, 4 per cent. for the year 1887, and to carry forward £185. 16s. 8d.

The dividend warrants will be issued on the 3rd of April.

7. Sir James Anderson and Mr. Etlinger are the Directors retiring by rotation, and being eligible offer themselves for re-election.

8. The auditor, Mr. Herbert R. Duke, retires, and offers himself for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The directors of this company announce a dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended 31st December last, payable on the 24th inst. The traffic receipts for the week ended March 16th amounted to £4,979.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The directors of this company announce the numbers of 113 bonds of £100 each of their 5 per cent. debentures (1880 issue) which have been drawn for payment at par on May 1st next.

EASTERN TELEGRAPH COMPANY.—The directors of this company announce the payment on April 14th next of a dividend of 3s. per share on the preference shares, less income tax, for the quarter ending March 31st, 1888, and an interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended December 31st, 1887. The register of transfers will be closed from April 6th to 13th, both days inclusive.

THE EXETER ELECTRIC LIGHT COMPANY (LIMITED).—The prospectus has been issued of the Exeter Electric Light Company (Limited), with a capital of £20,000 in 2,000 shares of £10 each, nearly one-half of which is said to be already assured. Mr. Massingham is to be managing director, and Messrs. Laing, Wharton and Down electrical engineers; the secretary and registered offices, Mr. H. W. Michelmore, 16, Cathedral-yard, Exeter.

THE LIVERPOOL ELECTRIC SUPPLY COMPANY (LIMITED).—The subscription list for the new issue of capital of this company is now closed. The number of shares applied for very largely exceeds the number that the directors have to issue. It is expected that the allotment letters will be sent out in the course of next week.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended March 16th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,181.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half-month ended March 15th, 1888, amounted to £3,333, as compared with £3,278 for the corresponding period of 1887.

REMOVALS.—We are informed that the registered offices of the National Telephone Company (Limited) will be removed on the 24th inst. to 162A, Queen Victoria-street, E.C., directly opposite St. Paul's station and close to Blackfriars Bridge.

—— Messrs. Thompson, Ritchie and Co., late of Winchester House, Old Broad-street, E.C., inform us that they are removing to more convenient premises, and that on and after the 25th inst. their address will be Connaught Mansions, Victoria-street, Westminster.

—— Messrs. B. and G. Shorthouse (manufacturers of copper wire for telegraph, telephone and all other uses, shaped copper and every requirement in metals for electric light companies, &c.), have removed their London offices to Mansion House-chambers, 11, Queen Victoria-street, E.C. Messrs. Applegarth and Stove, submarine and electrical engineers, are the sole agents.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Mar. 21, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending March 21, 1888. Highest.	Lowest.
£			**TELEGRAPHS.**		£. s. d.			
1,770,360	Stock	10/0	Anglo-American	38½ 39½	3 9 7	Jan., Apr., July, Oct.	39½	38¾
2,614,820	Stock	20/0	Do. Preferred	65 66	4 5 4	" "	65½	65
2,614,820	Stock	nil.	Do. Deferred	13½ 14½	...	February	14¼	13¾
130,000	£10	3/0	Brazilian Submarine	11⅞ 12⅛	5 16 8	Mar., June, Oct., Dec.	12⅛	12
16,000	10	8/0	Cuba Submarine	12½ 13	6 3 1	February and August	12¼	...
6,000	10	10/0	Do. Preference	18½ 19½	5 5 3	" "	...	...
			Direct Spanish	3½ 4	...	...	...	...
6,000	5	5/0	Do. Preference	9 10	...	April and October ...	...	...
60,710	20	2/0	Direct United States	8⅝ 8⅞	4 8 0	Jan., Apr., July, Oct.	...	...
380,000	10	2/6	Eastern	11½ 11¾	4 13 7	" "	11¾	11½
70,000	10	3/0	Do. 6 per Cent. Preference	14½ 15½	3 17 5	" "	15 1/16	14⅝
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	4 10 1	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅝ 12⅞	4 13 2	Jan., Apr., July, Oct.	12 13/16	12 9/16
22,050	10	5/9	German Union Telegraph and Trust	9¼ 9¾	6 3 1	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅝ 5⅞	4 18 0	Jan., Apr., July, Oct.	5 13/16	5 11/16
178,992	10	3/0	Do. 6 per Cent. Preference	13½ 13¾	4 7 3	" "	13⅞	13 7/16
150,000	10	5%	Great Northern	13¾ 14¼	5 5 6	Jan., July, and April	14⅛	...
17,000	25	5%	Indo-European	38 40	6 5 0	April and October ...	...	...
			London Platino Brazilian	5 5½	...	...	5¼	5⅛
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October ...	...	...
338,225	Stock	15½%	Submarine	135 145	9 9 0	February & August	...	...
30,000	10	6/0	West Coast of America	5¼ 5¾	8 13 9	January and July ...	5 11/16	5⅝
			Do. Debentures	111 116	...	...	...	...
88,321	10	nil.	West India and Panama	¾ 1	...	...	13/16	¾
34,563	10	9/0	Do. 1st Preference	10¼ 10¾	5 11 7	April and October ...	10⅝	10⅜
45,181	15	3/9	Western Brazilian	9¾ 10	4 6 2	March & September	9 13/16	9½
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	9/16 1 1/16	5 9 0	Yearly	..	...
			Oriental	¼ ½	...	...	...	...
80,000	£5	5/0	United	13¾ 14¼	4 11 3	June and December	14⅛	13⅞
			United River Plate	4¾ 5¼	...	...	...	...
			ELECTRIC LIGHT.					
	5		Anglo-American Brush (£4 paid)	2¾ 3¼	...	...	...	...
23,692	5	nil.	Do. (fully paid)	3¾ 4¼	...	February & August	4¼	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2½	...	...	2½	...
312,000	½	5% '86	Maxim-Weston	⅛ ¼	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	6 1 3	March and July	40	38½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	15 17	5 17 8	February & August	16¾	16½

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

The proposal to found an Association of Electrical Engineers has cropped up again in a new quarter, if not in an altogether new form. The April number of *Electrical Plant* treats us to a long article on the subject, demonstrating the futility of the original proposal and the highly feasible character of its own. As to the mode of carrying it out, namely, to constitute the Association a special section in the London Chamber of Commerce, we offer no opinion whatever. If it will satisfy the requirements of the trade we shall be quite content to support a scheme taking that shape; and if our contemporary can work it in that direction to the satisfaction of everybody concerned, we shall be as pleased as the rest.

But a "section of the London Chamber of Commerce" is not exactly an association such as our clients in these pages were desirous of forming, nor indeed such a one as *Electrical Plant* seems to be contemplating when setting forth the functions and objects of the proposed Trades Guild. What, however, we are chiefly concerned to notice in this connection is the erroneous description given of our own project, and the causes of its failure. We distinctly avowed the purely trade object of the association, and all along disclaimed any idea of trespassing on the ground of the Society of Telegraph-Engineers, or of any scientific body whatever. The fact may be usefully recalled just now, because if anybody else intends to succeed where we failed (assuming that we did fail) they must be prepared to face obstacles in the trading, not in the scientific, interests affected by the proposition.

We do not ourselves admit that we failed—quite the contrary; we succeeded in gathering all the elements of success together, and if this revival of the idea gets any further, it will be because we have smoothed the way for it. One reason—we need not refer to other reasons why the project went no further was no doubt the changed attitude of the Society of Telegraph-Engineers and Electricians. It was only fair to see what would come of its new designation. Apparently, *Electrical Plant* does not think so. Before the Society has had time even to formally alter its title, this new scheme is sprung upon it, as if the alteration meant nothing and would result in nothing. For our part we prefer to give the Society a fair chance of "living up to" its expressed ideal.

The Schanschieff battery is undoubtedly a very superior battery, and we endorse everything the experts have said about it; but, unfortunately, the public do not read expert evidence very carefully, or they would mark the limitations and qualifications with which that testimony is guarded. Unfortunately, too, the experts are not asked their opinion as to the money value of the article submitted to their examination. Seventy thousand pounds "in cash or shares," and 10,000 shares down of £5 each, is a remarkably stiff price to pay for any battery, "*some of* the qualities" of which are "superior" to those of all other voltaic batteries; and when a company starts to work it with this dead weight round its neck, and a capital of £200,000, its superiority as a marketable commodity becomes very questionable indeed.

It is curious to note in this relation how easily the financial world receives or rejects at pleasure the opinions of scientific experts. One financial organ, which fires a great boom on behalf of the "Schanschieff Electric Light and Power Company," and quotes with triumph the verdict of a very high scientific authority on the Schanschieff battery, contemptuously contrasts it with another kind of battery, which is called "a will-o'-the-wisp of its time"—evidently forgetting that it was launched with similar credentials from the self-same hand.

In our issue of July 1st, 1887, we published the full text of the Admiralty specification for engines and dynamos. With regard to the latter, we offered some criticism at the time upon the extremely rigorous stipulation with regard to the permissible rise of temperature, which was not to exceed 20° F. above the temperature of the atmosphere in any part of the machine. Our opinion of the practical impossibility of fulfilling this requirement was, doubtless, shared even by those firms who tendered for the work. We are glad to know, however, that in the specifications now issued the condition has been modified to the extent of applying the limitation to the armature conductors alone.

In connection with a very important scheme of electrical engineering (which has for some time been in progress, although the particulars have not yet been made public), there has recently come to our knowledge a very unfortunate instance of arbitrary interference on the part of the Board of Trade. Without going further into detail, it will be sufficient to say that the design originally contemplated a potential difference of 1,000 volts, and that it would be difficult to imagine any

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possible set of conditions under which a high tension could be employed with greater security and propriety. The question of public safety in this particular case simply does not enter into the problem. Nevertheless, the Board of Trade has thought proper to prohibit the use of a difference of potential greater than 250 volts. Since there is at the present time no recognised authority in existence to whose views the Board might be expected to defer, the contractors have nothing for it but to submit. The Society of Telegraph-Engineers and Electricians might possibly be induced to form a "Permissible Difference of Potential Committee," but we fear that in this case the time-constant would be so large that by the time its own differences of potential had been adjusted the matter would have been settled out of court.

IN another column will be found a description of a very remarkable and successful application of electricity to pumping in mines. In connection with this subject several letters have recently appeared in the columns of the engineering press advocating the employment of compressed air and questioning the practicability of electricity. Surely it is now incumbent upon these gentlemen to vindicate their position by figures and hard facts. In comparing the two systems one must bear in mind that the losses in the steam engine, pumps, and rising main are common, and can therefore be neglected as having no vital bearing on the real question. What we have to compare is the loss in dynamo cables and motor, and that in compressors, supply pipes, accumulators, and air engines. The loss in the cable and supply pipes may also be struck out as quantities varying in every case—they affect chiefly the capital outlay. Now, a good dynamo and motor have a joint conversion efficiency of not less than 75 per cent., and under favourable circumstances may rise as high as 82 per cent., or even 84 per cent. But what will the most sanguine partisans of the rival force say about the compressors and air engine? Will they claim 50 per cent. efficiency, and give the figures, as electrical engineers do? Probably, under very favourable circumstances, with low pressures, 50 per cent. might be reached, but with high pressure (such as would be required for 7,000 gallons per hour through 900ft.) without an extravagantly large plant, the efficiency would be probably not more than 25 per cent. at the outside. In addition to this we have the question of prime cost, which is all in favour of electricity.

IT is well known that in all electric power circuits the current is necessarily variable, owing to the changes of load; but even with comparatively constant work, where an ammeter will give practically steady reading, the fluctuations of the current are of great importance. Those makers who have had occasion to build large motors have for the most part been long aware of this fact, and it has been found necessary to increase the cross-section of the cut-outs in such circuits by 50 per cent. to 100 per cent. beyond what would usually be employed for the same average current in lighting circuits. The heating effect is, in fact, that due to the square of the mean current plus half the square of the difference between the maximum and the minimum currents. But this is not all; this large variation causes considerable increase in the heating of the iron of both armature and field, as the result both of hysteresis and of Foucault currents, and the effect will be the more marked as the density of the lines of force increases. In designing large machines this point is of special importance, and attention has to be given both to the arrangement of the iron and to the magnetic density. A case showing the possible magnitude of this heating occured in the Immisch pumping plant at Normanton, already referred to. It was found necessary in this case not to allow the density of the field to exceed 16 Kapp-units (or 15,350 C.-G.-S.) in the dynamo magnets, and 13 Kapp-units (or 12,500 C.-G.-S.) in the motor; the field is also laminated. With these precautions the results are perfectly satisfactory, and the rise in temperature in the motor and dynamo is approximately the same.

MEMBERS of the Society of Telegraph-Engineers and Electricians were provided with an unusual treat last Thursday evening in the beautiful experiments of Prof. RÜCKER and Mr. VERNON BOYS on stress and strain in the dielectric. The success of lecture experiments in which static electricity plays a part is always more or less problematical, and the admirable way in which the experiments "came off" after a little coaxing is a legitimate subject for congratulation. Prof. RÜCKER gave a very lucid account of the phenomena, and we hope to print it in our next issue. Meanwhile, we may remark that M. BLONDLOT has just published a paper on the same subject, in which he describes some experiments undertaken in order to settle an outstanding question, to which Prof. RÜCKER also made reference—namely, whether the effects of double refraction are really due to the setting up of a quasi crystalline structure in the dielectric, or whether they are merely a secondary result due to the mechanical pressure caused by electrostatic attraction. It has been suggested that in the latter case convection in the liquid would account for the observed phenomena. M. BLONDLOT therefore devised an *experimentum crucis* to test the truth of the latter hypothesis. If convection had anything to do with the matter, owing to the inertia of the liquid, some interval would elapse between the establishment of the electrical condition and the appearance of the corresponding optical phenomena. M. BLONDLOT has shown by experimental evidence that if there be any such interval it is certainly less than $\frac{1}{10000}$sec. But, apart from this, since the experiment, though difficult, sometimes succeeds with glass, it does not seem that convection could, under any circumstances, offer a complete explanation.

AFTER Prof. RÜCKER'S lecture, the Society had an opportunity of trying the Robertson Writing Telegraph, a set of instruments having been set up in the lecture room. This instrument—which has already been described in our columns—would undoubtedly have been of much practical importance if its invention had only preceeded that of the telephone.

BUT whilst the Society as Electricians are studying stress and strain in the dielectric, and as Telegraph Engineers are investigating the writing telegraph, the Electrical Engineers are bitterly complaining of the stress and strain due to con-

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flicting Fire Office Rules. With much that our correspondents have to say we are fully in accord, but we think it a pity—since matters have been allowed to drift into the present state—that a disposition should be shown to reject the good offices of the Society in bringing the question to an issue. That something will have to be done to avert the threatened state of chaos is certain. It is equally undeniable that the parties primarily concerned are the Fire Offices on the one hand and the electrical contractors on the other. But the essence of the difficulty lies in a fact that does not seem to be generally appreciated or understood—namely, that the Fire Offices are very far from working together harmoniously in this matter. Furthermore, it will make little difference to the latter whether any standard rules are or are not agreed upon; but it will make a good deal of difference to the contractors. Since no recognised association exists whose competency to deal with such a question is recognised by all concerned, the best thing for the present is simply to suspend our judgment until after the report of the Society of Telegraph-Engineers' Committee has been made public. This, as we announced last week, will take place at an early meeting of the Society.

FURTHER complaints reach us on the subject of trade catalogue piracy. From Messrs. WALTER T. GLOVER AND CO. we learn that several pages of their price list have been reproduced, word for word, as original matter in the catalogue of another firm who manufacture the same class of goods. A like compliment is sometimes paid to ourselves by the republication—without acknowledgment—of tables and formulæ which first appeared in *The Electrician* and the "Electricians' Directory." The practice is in every way to be deprecated, and our correspondents even suggest that the Society of Telegraph-Engineers and Electricians should take the matter up—at all events, so far as the interests of electrical trades are concerned.

AS an illustration of the improved tone of the gas journals towards the electric light, we note the *Gas World* of last week quoting with approval a speech of Mr. FRANK RIDLON addressed to the New England Association of Gas Managers, in which he predicts that the gas engineers and electrical engineers "are destined to come together in the future as practical engineers" for the public service. Mr. RIDLON is himself an electric light engineer; and the *Gas World* praises the friendly feeling which inspired his words on the occasion referred to, adding an opinion of its own that it would be an agreeable change at the Gas Institute if a recognised authority on electric lighting were occasionally heard at its meetings. It would be a change, no doubt, and we hasten to say that it would be one quite agreeable to us.

AT the meeting of the Maxim-Weston Company, held yesterday, and reported in another column, it will be seen that Mr. HUGH WATT, M.P., entered into a detailed explanation of the position of the Company. He stated that the reason for the non-payment of a dividend this year was that three important contracts had fallen through, causing a decrease in the profits, compared with those of the previous year, to the extent of £3,000. Perhaps, the most remarkable feature of the long and animated discussion which followed was the speech of Mr. LOUIS SWABY (a director of the company), in which he maintained that the balance-sheet was a farce, and disclaimed any responsibility for it. After the adoption of the report and accounts, a committee of five shareholders was appointed to confer with the directors on the affairs of the company, and the meeting was adjourned for four weeks.

The Forbes Meter.—It is stated that the Westinghouse Electric Lighting Company has adopted Prof. Forbes' current meter.

Obituary.—Mr. Edward Dwyer Gray, M.P., who was chairman of the Telephone Company of Ireland, died at his residence, Dublin, on Tuesday night.

American Competition.—According to the *Financial Times* "large orders of electric light machinery are being shipped from New York to Europe and Great Britain."

Lighting of Railway Stations in France.—The Chemin de fer du Nord are about to light several of their provincial stations by electricity, and the lighting of the St. Denis station will be extended.

Spanish Tenders for Telephone Service.—The *Madrid Gazette* of the 23rd March contains a Royal order for tenders to be invited for the establishment and working of a telephone service in the manufacturing town of Alcoy, Province of Alicante.

The Lighting of H.M.S. "Nile."—The magnificent ironclad the "Nile," which was launched from Pembroke Dockyard on Tuesday, is lit throughout by 500 incandescents, and carries four powerful search lights. The current is supplied from three dynamos, each capable of giving 400 amperes.

Electric Light at Falcon Cliff, Isle of Man.—Messrs. C. L. Baker and Co. (Limited), of the Cornbrook Telegraph Works, Manchester, are engaged in fitting up Falcon Cliff Hotel, pavilion and grounds with the electric light. The installation will consist of ten arc lights of 2,000 candle-power, and over 400 incandescent lights.

Taunton.—The organ at St. John's Church, Taunton, is to be blown by electricity. The posts to carry the wires have been placed across the lower end of the Crescent-field, and the work is to be finished in about a week. It has created much interest in the town, and is being carried out by the Taunton Electric Light Company.

The New York "Electrical Review."—The prosperity of electrical business, and consequently of electrical journalism, in the United States is indicated by the enlargement and improved appearance of such papers as the New York *Electrical Review*, which this month starts a new series with an artistically designed wrapper and a wider range of contents.

Alleged Electrical Fire at Lucerne.—An hotel was last week burnt down at Lucerne, and a statement appeared in the local papers, and has been reproduced in this country, alleging that the fire was caused by the electric light fittings. We have, however, received a telegram from Messrs. Ganz and Co., of Buda-Pesth, contradicting that statement.

The City Guilds Institute.—From a copy of the *Journal* of this Institute for the month of February we observe that the old students' *Journal* has been incorporated with it, and that the contents are more varied and interesting than ever. We are pleased to see this evidence of *esprit de corps* among the students and staff of the Finsbury, Kennington, and Kensington Colleges.

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Fire Alarms.—The Watch Committee of Stockport invite tenders to provide and erect fire alarm signals, consisting of electric bells and telephone. Particulars can be obtained of Superintendent Buck, Police Office, Stockport, and tenders must be endorsed "Tender for Fire Alarms," and be delivered to Mr. W. Hyde, town clerk, by 10 a.m. on the 6th of April.

A Mistake.—At Pittsburgh recently a company working an electric tramway on the conduit system had a large quantity of salt sprinkled on the line in order to melt the snow. As the conduit was made of wood, and the potential difference was 500 volts, the result can easily be imagined. The melted salt and snow soon bridged across the conductors, and the woodwork was set on fire.

The Electro-Harmonic Society.—The last smoking concert of this society for the present season will be held on Friday, April 6th, at the St. James's Hall Restaurant (banquet room), to commence at eight o'clock. A capital programme has been arranged, including a violin duet by MM. Jacques Greebe and T. E. Gatehouse, and some readings by Mr. Charles Fry. Musical directors, Mr. T. E. Gatehouse and Mr. Arthur Thompson.

Cold Soldering for Copper Wires.—In the *Elec. Tech. Zeits.*, Berlin, Herr Muller, of the Telegraph Service, suggests the use of cold soldering for hard-drawn copper and bronze wires, so as to avoid softening the wires by heat. He prepares his solder by heating precipitated copper made in a stream of hydrogen. The reduced copper when quite cool is rubbed in a mortar with mercury and very weak sulphuric acid, and then well washed.

A Source of Error in the Quadrant Electrometer.—M. Hallwachs has pointed out that in the quadrant electrometer a source of error may sometimes exist owing to the differences of potential between the various metallic parts of the instrument which are insulated from one another. This error may, of course, be minimised if the precaution is taken of "earthing" every part of the apparatus immediately before making an observation. It is also evident that in the case of alternating currents the error from this cause does not occur.

The Irish Exhibition in London.—We are extremely glad to notice that the arrangements are now completed for this interesting exhibition of Irish art, industry, and trade during the coming summer. It will be held in Olympia, Kensington, and is expected to be open from June 4 to October 27. The object is a most praiseworthy one, and being entirely outside politics it has secured the support of a remarkably numerous and powerful body of patrons. The usual rules relating to patent exhibits will apply, the exhibition being certified as an international one by the Board of Trade.

United Cables v. Truro F.C.—This match was played on Saturday last (24th) at Penzance during a heavy snowstorm. The United Cables won by three goals to one, which were obtained by Messrs. Walton, M'Lean and W. Raymond. The United Cables have only played four matches this season and have won them all. Team as follows :—M'Lean and Walton, right wing; Henderson and Mackenzie, left wing; Raymond and Adson, centre; Leahy and Davies, half-backs; Mathews and Palmer, backs; Thorngate, goal. All are Exiles with the exception of Adson and Walton, who have, nevertheless, rendered good service on every occasion.

Royal Institution.—The following are the lecture arrangements after Easter :—Dr. Charles Waldstein, three lectures on John Ruskin; Mr. Walter Gardiner, three lectures on The Plant in the War of Nature; Mr. Sidney Colvin, three lectures on Conventions and Conventionality in Art; Prof. Dewar, six lectures on The Chemical Arts; Prof. T. G. Bonney, three lectures on The Growth and Sculpture of the Alps; Mr. Carl Armbruster, seven lectures on The Later Works of Richard Wagner (with vocal and instrumental illustrations); Prof. C. E. Turner, three lectures on Count Tolstoi as Novelist and Thinker. The following are the probable arrangements for the Friday evening meetings after Easter :—Prof. Flower, The Pygmy Races of Men; the Right Hon. Sir William R. Grove, Antagonism; Mr. James Wimshurst, Electrical Influence Machines; Prof. J. K. Laughton, The Invincible Armada: a Tercentenary Retrospect; Mr. W. H. Barlow, Building the New Tay Bridge; Mr. Francis Galton, Personal Identification and Description; Prof. J. A. Ewing, Earthquakes and How to Measure Them; and a discourse by Prof. Dewar.

Telegraphic Communication.—In the House of Commons on Tuesday last, in answer to Mr. Causton, Mr. Raikes said: In reply to the hon. member, I have to say that I have no official information of the inconvenience and loss which have resulted from the breakdown of telegraphic communication in New York, but I understand that the breakdown was caused by a snowstorm, which damaged the wires. About 50 per cent. of the telegrams of the United Kingdom pass through the central telegraph office in St. Martin's-le Grand. Only on the top floor of that building are the fire hydrants not supplied from the street mains; they are supplied from tanks on the roof containing 28,000 gallons of water pumped up from the artesian well on the premises. It is not true that the building was in any danger from a fire in Paternoster-row. The present arrangements have been made after mature consideration, and there is no intention to establish a duplicate central telegraph office. The building, I may add, is fireproof throughout.

Electric Traction on the Brussels Tramway.—We regret to observe that the experiments which have been carried out on the Brussels tramways in electric traction by means of the Julien accumulator have not led to results of a satisfactory character. The report of the directors of the Tramway Company, which was presented at a recent meeting of the shareholders, contained the following passage :—"Yielding to a desire manifested, or rather to a requirement formally expressed, at the general meeting held on March 15th, 1885, by an important group of shareholders, we have made trials with electric traction. Hitherto, these experiments have not responded to the expectation of the promoters. The first car commenced to run on the 17th April [1887], in the Rue de Belliard and the Place Royale, a second was added on the 8th May, and a third on the 17th September. The electric cars during 1887 ran a total distance of 54,987 kilometres, representing 4,800 horse journeys. We are still endeavouring to improve the economical conditions, particularly as regards the cost of maintenance of the apparatus [? the batteries]. Until this has been accomplished we do not see our way to augment the number of cars in use."

Douglas, Isle of Man.—On Thursday last a public meeting was held in Douglas, in order to consider the question of forming a company to provide the town with electric light. Mr. Alexander Siemens addressed the meeting, and gave facts and figures in connection with the more important installations carried out during the last few years by his firm. To light the Promenade with eight arcs ought to cost 6d. per lamp per hour, or 16s. a night, say £100 for the season. The company would be able to make a profit by supplying current to private houses at the rate of ½d. per lamp

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hour. The following resolution was carried unanimously :—"That in the opinion of this meeting it would be to the advantage of the town of Douglas if a system of electric lighting from a central station were established without delay, and the meeting will do all in its power to further the taking up of the shares in the Electric Lighting Company." After the meeting a conference took place between Mr. Siemens and others interested in the formation of the company and the Douglas Town Commissioners. Mr. Siemens laid before them a definite proposal with reference to lighting the Promenade with the electric light, but the members present decided that they could not entertain the proposal until the company was floated.

Electric Lighting on Steam Yacht "Wanderer."—This magnificent vessel, owned by Prince Tartonia, of Rome, has just been fitted with a very elaborate installation of electric light by Messrs. Muir, Mavor and Coulson, of Glasgow. The plant consists of the following :—A steam boiler built on a modification of Cole's patent, designed to give 12 indicated horse-power, at 80lb. pressure; a Willans compound central valve two-crank engine, mounted on the same bed-plate with and coupled direct to the dynamo, which is driven at 445 revolutions per minute (the engine is fitted with light feed lubricator tachometer and Willans governor); a dynamo with a maximum output of 10,000 watts, giving an E.M.F. of 75 volts as a simple shunt for charging batteries, and 60 volts as compound for running the lamps direct; a complete auxiliary condensing plant, consisting of a copper condenser and a set of circulating air and feed pumps mounted on the same bed-plate with and driven through worm gearing by a special double acting high-speed vertical engine; an accumulator with a capacity of 630 ampere hours, the plates of which are in teak wood boxes, which are carried on massive racks and rigidly secured by wedges. The space available for fixing the above plant is admirably suited to the purpose, being two large cabins on the main deck, abreast of the engine room, with doors opening to the middle platform. Steam connections are provided from both the main boilers and the auxiliary boiler; the engine has also three alternative exhausts: 1st. To the main condenser, for use while at sea and steaming, from the main boilers; 2nd. To the auxiliary condenser above mentioned, for use while in port; and 3rd. Through a non-return valve to the atmosphere under the water line. The hot water from the auxiliary hot well may be delivered to either or both the main boilers, or to the auxiliary boiler. The drains may be directed to the bilge or the auxiliary condenser. The main conductors from the dynamo are brought to a handsomely-fitted switch-box with instruments mounted, affording very complete control of the circuits and accumulator. A search light of 2,000 candle-power is fitted on the navigating bridge, and a gangway lamp of 200 candle-power in a large lantern is suspended over the ship's side from a special davit. The fittings throughout are of very handsome pattern, and the wiring has been carried out with special reference to neatness and security. The mains are brought to double-pole fuse boxes, with slate bases where the fuses are centralised, and the branch wires led away in grooved casings of maple or Hungarian ash, with polished covers. The contractors have spared no trouble in their efforts to make this one of the most complete sets of apparatus afloat.

The Equitable Telephone Association versus the United Telephone Company.—The following circular has been issued by the Equitable Telephone Association :—

"The United Telephone Company having commenced proceedings for infringement, which they are advertising in the public press, against the Equitable Telephone Association, and having obtained against the latter association an interim injunction, which they are also advertising, pending the trial of the action, which trial cannot come on for some months, the Equitable Telephone Association think it right to justify the conduct of their past business.

"The association was incorporated as long ago as the 15th December, 1886, and although advised by eminent counsel that the instruments intended to be used by the association were not infringements of the patents held by the United Telephone Company, yet the directors of the association thought it right, having been informed of the pretensions of the United Telephone Company to a monopoly of the telephone business of the country, before commencing to supply instruments, to challenge the United Company to attack such instruments, with the hope and intention that the challenge would be accepted, and the litigation, which was then considered inevitable, terminated before the association commenced to supply telephones to the public.

"With this view the following letter was addressed by the solicitors of the association in February, 1887, to the United Company, giving express notice of the intention to manufacture and sell telephonic apparatus under Mr. Swinton's patent, and challenging the United Company to attack, if they dared do so, the instruments proposed to be manufactured and sold :—

'40 and 42, Queen Victoria-street, E.C.,
'February 25, 1887.

'DEAR SIR: We are instructed by the Equitable Telephone Association to inform you that the association is about to manufacture and sell telephonic apparatus, the transmitter of which is constructed under the various patents of Mr. A. A. Campbell Swinton, whose patent rights the company has purchased.

'In order to give you an opportunity of inspecting the instruments, a set has been fitted up at these offices, and we are prepared to arrange an appointment to produce them for the inspection of yourself and your company's electricians.

'We should add that the company is advised by eminent counsel that the instruments are in no way infringements of the patents held by your company, but knowing the extent of the claims made by your company—ill founded claims, we believe—to altogether prevent the use of any electric transmitters in which carbon is used, the board of directors of our company think it right to give your company distinct notice of the intentions of the association with a view to challenging your company to contest the right of our company to manufacture, use, and sell the instruments in question, should your company after inspection think fit so to do, a contest which our directors will enter into with the full assurance they will succeed in maintaining the instruments it is the object of the association to deal with.

'Yours faithfully,
'DAVIDSON AND MORRISS.'

"To this challenge the United Company did not respond, and until the 9th of the present month of March, when a writ was issued without any previous warning or notice by the United Company against the association, no objection was made by the United Company to the business the association was transacting. The writ was followed by a motion for injunction, which was heard on Friday, 16th March, when an interim injunction was granted, restraining the association in the usual terms from dealing with telephonic instruments, the United Company giving the usual undertaking to be answerable in damages caused to the association.

"Owing to the short time at their disposal, the association was practically precluded from producing any scientific evidence on the hearing of the above motion, and their defence, therefore, rested solely on the question of there having been undue delay on the part of the United Company.

"The association have every intention of contesting the action to the utmost of their ability, and they will press the case on as far as lies in their power, with a view to as early a trial as practicable.

"They believe that they have a complete defence, and they have every confidence that they will be able to uphold the complete freedom of their instruments."

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HIGH-RESISTANCE METALS AND ALLOYS.

BY W. M. MORDEY.

There are two principal purposes for which resistances are largely used in heavy electrical engineering, in connection with which it is important that the heat generated by the current should not seriously increase the resistance. The first is the ordinary testing of dynamos, where it is necessary to dissipate the energy easily, and where the use of arc or incandescent lamps or of water resistances is inconvenient or expensive. By using wires of known resistance, the temperature coefficient being low, the operation of taking routine measurements is simplified. It may suffice to measure the current only, the potential difference being estimated within one or two per cent. from the resistance of the circuit measured cold, and from the assumed temperature. In the case of dynamos of 2,000 to 3,000 volts, like the large Brush machines, such a test is convenient when machines are being made in quantity.

Whether for such comparatively coarse measurements, or for work requiring greater accuracy, resistances of fixed or nearly fixed value are of great assistance. It is possible, by using very large coils and by providing abundant means of cooling, to keep the actual temperature of the wires down to any required point; but in practice this is inconvenient, and it is therefore very necessary to ascertain what is the best material to use when constructing resistances for such purposes.

COMPARATIVE TEST OF WIRES OF VARIOUS METALS.

All wires of 1 foot long, ·001 section.

Temperature. Degrees. Fah.	Cent.	Hadfield's Non-Magnetic Steel.	Arsenical Copper.	Platinoid.	Piano Steel.	German Silver.	Hard-drawn Brass.	Soft Iron.	Copper.
62	17	·3084	·2371	·165	·1329	·0571	·0502	·0438	·00831
100	30	·3561	·2418	·17	·173	·0576	·0556	·0533	·00979
120	39	·3636	·2433	·171	·1779	·0578	·0559	·0567	·00984
140	60	·3713	·2448	·1712	·1804	·0584	·0569	·0589	·00993
160	71	·3732	·2465	·1718	·1976	·0589	·0575	·0614	·01033
180	32	·379	·2474	·172	·2062	·0594	·0576	·0642	·01052
200	93	·3828	·2479	·1726	·197	·0599	·0578	·0676	·01067
220	104	·3867	·2487	·1728	·1834	·06028	·0584	·0719	·0110
240	116	·3905	·2507	·1732	·1976	·0611	·0592	·0751	·0115
260	127	·394	·2527	·1742	·2007	·0618	·060	·0774	·01178
280	138	·396	·2543	·1746	·2081	·0629	·0606	·0805	·012
300	149	·401	—	·1748	·2173	·0631	0611	·0838	·01264

The other purpose to which allusion was made is the construction of resistance coils for placing in series with arc lamps supplied from constant pressure mains. In such cases it may happen that an arc lamp when switched on will not strike its arc promptly, thus allowing an excessive current to pass through the resistance, which if of an unsuitable metal will rise so much in value that it absorbs considerably more than is desirable of the available pressure, so that when the arc is formed its potential difference may be too small, resulting perhaps in extinction and a repetition of the objectionable action. Such a rise of resistance may, of course, sometimes be of actual advantage in preventing the passage of very large currents; but it should not be necessary to have to rely upon a resistance for this. A simple calculation will enable any one to see that the conditions which on a parallel system are most likely to result in a steady light are best obtained by using a resistance whose value does not alter with the current.

By the kindness of the Brush Corporation, the writer was able to carry out a few experiments on the metals and alloys named below.

The resistance measurements (*see* Table) were for the most part carried out for the writer by Mr. Money, an assistant in the works of the Corporation, on such wires as came to hand. In all cases these wires were of sufficient length to be very readily measured by a Wheatstone bridge, using a Thomson reflecting galvanometer. They were coiled on small frames of wood, and placed in an oil bath which was heated by a Bunsen burner (the oil being stirred so as to assure an even temperature throughout the bath). As no current traversed the wires except that used for the measurement, the temperature of the wires was always that of the oil in which they were immersed.

From the resistances so obtained the diameter, as measured by a micrometer gauge, and the length, the values given in the table were calculated.

Taking as unity the resistance of the copper—which was of the quality now generally obtainable for dynamo work—we have the following comparative values:—

Copper	1·	Piano steel	16·
Soft iron	5·27	Platinoid	20·
Brass (hard drawn)	6·05	Arsenical copper	28·5
German silver	8·83	Hadfield's manganese steel	37·1

From the table the following values are obtained for temperature coefficients for the range of the experiments, which is sufficient to cover what may be called ordinary working temperature, even for purposes where a good deal of heating is admissible:—

VARIATION PER 1° CENT.

Platinoid	·044	Hadfield's manganese steel	·229
Arsenical copper	·061	Copper	·396
German silver	·080	Piano steel	·517
Brass (hard drawn)	·164	Soft iron	·691

A prominent place in the last list is occupied by arsenical copper, an alloy having the appearance of copper, to which the writer's attention was drawn by Mr. J. Raworth, who had noticed its freedom from variation at a time when German silver was generally regarded as the alloy having the lowest temperature coefficient. It was to ascertain definitely this coefficient, and to find the other properties of the alloy, that these experiments were commenced, the other metals being examined afterwards for comparative purposes. From an electrical point of view arsenical copper is a very interesting, but not altogether satisfactory alloy. It was introduced some years ago for resistance coils, but so far as the writer is aware never seems to have attracted the attention it undoubtedly deserved. The few samples tried showed inequalities both in the specific resistance and in the temperature coefficient. As to its composition no information is at hand, but its very high specific resistance—about three times that of German silver and 28·3 times that of copper, one sample giving a still higher result—and its low-temperature coefficient should make it suitable for resistance coils for bridges, &c., if equality can be relied on. It is, however, not a very satisfactory material for coils for large currents, as when an open coil of it is much heated in the air its surface becomes blackened; and under conditions which do not permanently injure some of the other metals, it is seen to "sweat," and even to give off slight fumes. After being heated in this way its resistance is permanently increased, no doubt by a slight decrease in the diameter of the wire. Another objection to its use where excessive heating is to be expected is its want of rigidity. Like copper, when wound in an open coil or helix and suspended, arsenical copper wire droops very much when heated, so that the lower turns of the helix almost

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or quite touch one another, and there is no very marked recovery on cooling. Perhaps, however, improvements may be made in this material which will bring it into competition with platinoid. At present, although possessing in a remarkable degree some of the qualities demanded by electricians, particularly a very high specific resistance, it cannot be stongly recommended.

With regard to platinoid, the figures obtained are in accord with results already published. It should be borne in mind, however, that in this case, as in the others, the "temperature coefficient" depends, to some extent, on the range of temperature employed in the experiments. The variation is a curve, and not a straight line, rising more rapidly as the temperature increases; thus by taking a small range at a low temperature the coefficient obtained is more favourable to constancy than if a greater range is taken. The former is allowable where only ordinary atmospheric variations are in question; but for real "heating," such a coefficient does not hold good. Nothing more need be said of platinoid; this material is already well known. While not as high in specific resistance as others, its other good qualities more than make up for the deficiency. The German silver and brass samples present nothing of special interest. The piano steel was found very high in specific resistance, but still higher was Hadfield's manganese steel. The direct relation between magnetisibility and conductivity, which was pointed out some years ago by Prof. Hughes, is here amply illustrated. Manganese steel is practically non-magnetic, and has a resistance about 37 times that of copper, and about six times that of iron, a very pure, soft sample of which was tried.

There is another use to which metals of high specific resistance will probably be largely applied in the future, namely, for the construction of those parts of dynamos, particularly of alternate-current dynamos, where strength is required in combination with high magnetic and electric resistance. For non-magnetic supports, for the ends of armature coils, for hubs of alternate-current machines, and for many purposes which will readily occur to the reader, there is felt at present a need for a good and inexpensive material. For these purposes German silver has been used in the past, but it is expensive, and castings are not always very satisfactory. Besides, its quality is variable, the term "German silver" (like "brass") being a rather loose one. The material which more than any other appears to hold out a promise of being useful is Hadfield's steel. Its strength is very great, magnetically it is as good—or as bad—as brass, while its resistance is the highest of any, so that losses from eddy currents will be small. Further, although its temperature coefficient is high enough to disqualify it for resistance frames, this very property is in its favour for fittings and supports. Unfortunately there is at present one very great objection to it—it is so hard that it is impossible to work it. It is to be hoped that Messrs. Hadfield, who have shown so much enterprise in bringing this steel forward, will be enabled to overcome the difficulties which stand in the way of its employment by electric engineers.

PUMPING IN MINES BY ELECTRICITY.

Some four months ago *The Electrician* contained descriptions of two pumping plants in which the energy was transmitted from the surface to the pit bottom by electricity. The motor and dynamo for one of these were made by Messrs. Immisch and Co., of Kentish Town, London, and the work was carried out under their superintendence. The other was designed and erected by Mr. Brain, of the Trafalgar Colliery.

Both of these installations are interesting as practical successes; but, in point of size, both are insignificant beside another pumping plant which Messrs. Immisch and Co. have now laid down at Messrs. Locke and Co.'s, St. John's Colliery, Normanton.

This new plant is designed to cope with a salt-water feeder of 5,100 gallons per hour, at a vertical depth of nearly 900ft. below the surface. It was decided to raise the water at one lift, and at a rate of about 7,200 gallons per hour, so that the pumps could stand, if necessary, for six hours out of the twenty-four. Since the pressure on the ram faces is about 400lb. per square inch, specially-designed pumps were required, and the electrical plant had to be designed to suit the given conditions. The pumps are differential, with two 6in. and two 4½in. rams, and when doing full duty they run at twenty-five revolutions per minute. It was found, by a preliminary trial of a smaller plant, that the load on the rams varied largely at different parts of the stroke. To avoid the heating that would be entailed in an ordinary motor working under a large current with a regular and rapid variation in its intensity, it was necessary to specially design the field and armature. Messrs. Immisch and Co. have successfully met the difficulty, and the plant has now been raising about 125,000 gallons per day for the last month. To give some idea of the electric problem we may say that the current averages 66 amperes, as read by a Siemens dynamometer, but varies at least 10 amperes on either side of the mean value. It is well understood that the heating effect of a varying current is not proportional to the square of the mean current, but is equal to that plus half the square of the variable part. But, in addition to this, the rapid variations of current increase largely the heating effects due to hysteresis and Foucault currents.

The tension on the dynamo terminals is 600 volts, on the motor 575 volts. The actual power spent on the water, at the rate of 120 gallons per minute through 900 feet, is 33 horse-power nearly. The output of the dynamo is 53 horse-power. Hence the efficiency between the actual useful work and the output of the dynamo is $\frac{33}{53} = 62$ per cent. approximately. The commercial efficiency or ratio of useful work to belt power in dynamo cannot yet be stated accurately, owing to slip in the dynamo belt. However, taking the efficiency of conversion of the dynamo at the low estimate of 85 per cent., the commercial efficiency is not less than $\frac{33}{62 \cdot 5} = 50$ per cent. approximately.

It must be remembered that this efficiency includes all the losses in transmission, viz., that in the dynamo, leads, motor, gearing, pumps, and rising main pipes. In this particular case about 2·5 horse-power is lost in the cables, and some 13 horse-power is absorbed by the gearing and pumps, and by friction of the water in the pipes. It is shortly intended to make a more complete test. Then indicator diagrams will be taken of the engines and pumps, and the various losses will be determined very exactly. But returning to our 50 per cent. conversion between the measured quantity of water and the brake engine power, could compressed air give such a return? The writer, from his experience in this class of work, believes that compressed air would not give a return of more than 20 per cent. of the brake engine power. At any rate, it is curious that not one of the advocates of pneumatic transmission will publish a test of his plant. The writer has spoken to several mining engineers who have carefully measured the water delivered and indicated their engines, with results varying from 15 per cent. to 25 per cent., and this latter under most favourable circumstances.

Another important point of comparison lies in the prime cost of the plant. Omitting again the factors common to both systems, we have first a leading and return cable to set off against the pressure pipes. In most cases, the writer takes it, the cables will cost both less than the pipes, and will be far cheaper to erect. A double cable to transmit 50 horse-power was run by Messrs. Immisch and Co. down a shaft 300 yards deep in seven hours. The dynamo and motor will be found also to cost less than the compressors, accumulators, and air engine to do the same work. The former cost something like 25 per cent. less than the latter.

The question of prime cost is an important one; but, perhaps, that of maintenance and security of running is more important still, in cases where breakdowns may entail very serious consequences. With electricity the cost of maintenance is practically limited to the wear of brushes, commutators, and bearings.

Of course, electrical plant requires to be properly designed

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for its work and to be well laid down. But the majority of accidents that are likely to happen to such plant can be readily and quickly repaired, and compare very favourably with the ugly breakdowns that occur with machines containing reciprocating parts; indeed, if a proper method of management and daily testing of the system be made, a really serious breakdown is a very unlikely thing, for a fault is easily detected and made good before damage is done. With compressed air plant there is not so much a risk of a bad breakdown as a continual fettling up of the brasses, crank pins, cotters, valves, valve seats, glands, &c. The number of wearing parts is so numerous and the strains so various that it is not to be wondered that the cost of maintenance is comparatively heavy.

In conclusion, it may be mentioned that the motor weighs about 3½ tons, and the dynamo nearly 4 tons. The machines are much heavier than the ordinary Immisch type for traction purposes, in which every 70lb. of dead weight gives approximately a brake horse-power. But here weight did not enter into the question so much as slow speed and cool running. They are working well within the limits of their design, and are capable of doing 50 per cent. more work if necessary. The armatures, 24in. in diameter and 16in. long, are of the cylinder type, with massive commutators and substantial brushes and holders. The motor is wound according to the well-known plan adopted by this firm, in which the coil at the neutral point is short-circuited, and to this is mainly attributed the fact that they run practically sparkless, with a constant lead, although the load is varying 30 per cent. during every revolution of the pump. Electricians will appreciate what this means. The speed of both dynamo and motor is 450 revolutions per minute. The engine is a compound semi-fixed, by Messrs. Robey and Co., of Lincoln, of thirty horse-power nominal, and works at a boiler pressure of 140lb. per square inch.

That the plant is a success may be judged from the fact that Messrs. Locke and Co. have given an order for two new machines of the same power. The new plant will be used to work an endless rope on an engine plane by day, and will be ready for pumping at night if required. This electrical plant is by far the largest at present running at a coal mine, but it may be confidently expected that it will not long remain singular in this respect.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER VIII.—*The Calibration of Current Indicators.*

(Continued from page 544.)

97. *The Tangent Galvanometer as a Standard Instrument of Comparison.*—By a standard instrument is meant one in which the deflections of the needle are directly proportional to the currents passed through the coil, or one in which the current is proportional to some known function of the angle of deflection. This latter condition presents itself in the well-known *tangent galvanometer*, in which instrument the currents passing through the coil are proportional to the tangents of the angles of deflection of the needle. The reason for this action will be fully explained in the chapter on galvanometers, but it may be stated here that in order that an instrument may read tangentially the magnetic field of force produced by the current must be uniform throughout the full range of movement of the needle. To ensure this the needle is made very short in length, not more than one-tenth the diameter of the coil. The coil itself is generally made circular in shape, though not necessarily so; and the needle is pivoted or suspended horizontally at its centre. One of these instruments is shown in Fig. 56. The coil frame C C is circular, and the small needle hangs by a single silk fibre in the centre of the coil, immediately above a graduated dial, D D. The needle is carried in a little stirrup of aluminium, to which a long, fine glass pointer is attached at right angles to the needle. The two ends of this pointer move over the scale divisions on D D, which are marked out in degrees of arc on one side of the coil, and in divisions proportional to the tangents of those degrees on the other side. Hence readings can be taken over either scale by reading from either end of the pointer, and if the tangent divisions are read the deflections are directly proportional to the strength of current—that is to say, if the readings so taken and their corresponding currents were plotted together we should have a

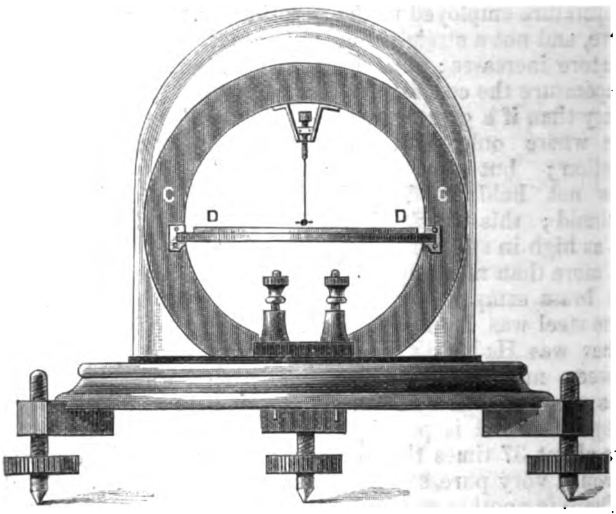

FIG. 56.

straight line, showing them to be absolutely proportional to each other. If, however, the *angles* of deflection are read off and plotted with the corresponding currents producing them, we should have a true tangent curve exhibited. It may be of interest to show this curve and the method of constructing it.

98. *Graphic Method of Constructing a Tangent Curve.*—In Fig 57 the needle of a tangent galvanometer is shown at $n\ s$, with

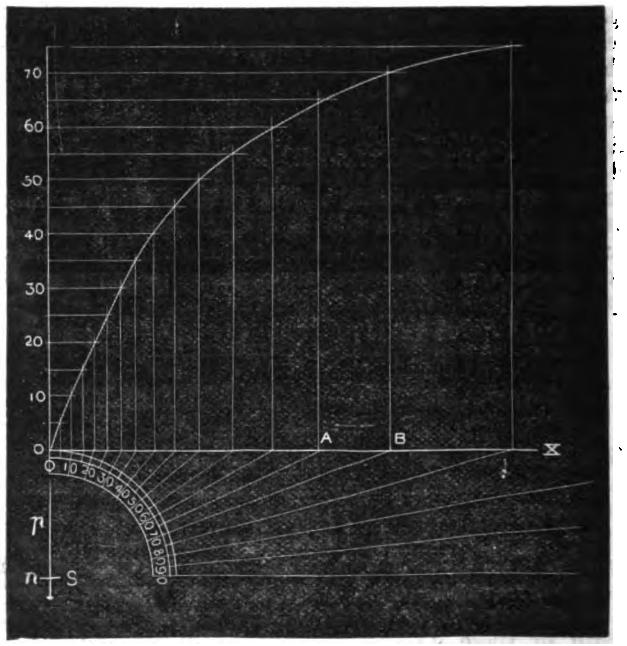

FIG. 57.

its pointer, p, attached to it at right angles. When there is no current passing through the instrument, the pointer will be at zero, and the needle will lie in the same plane as the coil (not shown). Now, when currents of varying strengths are passed through the coil the needle will be deflected, carrying with it the pointer, which moves over a scale graduated in degrees, from which the angles of deflection can be read off.

Now, the currents are not proportional to these angles of deflection, but to their tangents; that is, a current causing a deflection of, say, 60 degrees would not be twice the strength of current causing 30 degrees deflection, but the current strengths would be in the proportion of tan 60 to tan 30. Graphically, we may represent these tangents by distances along the line O X, by drawing lines from the centre of the needle to the various angles on the scale, and producing them till they cut the line O X; the distances from O are then proportional to the tangents of the corresponding angles. For, example, taking the two angles 65 degrees and 70 degrees, the respective distances O A and O B are proportional to the tangents of these angles, and so on for every other angle. For calling the distance from O to the centre of the needle the radius of the arc, we have the actual tangents of the angles moved through by the pointer p (and therefore by the needle, since it is fixed to the pointer), equal to their respective distances along O X divided by the radius; thus,

$$\tan 65^\circ = \frac{O\,A}{\text{radius}},$$

$$\text{and } \tan 70^\circ = \frac{O\,B}{\text{radius}},$$

and so on for all angles. Now, since the radius is common to all, it is evident that distances along O X simply are proportional to the tangents of the angles.

Hence the points on the line O X, found by lines drawn from the centre of the needle through the angles to the horizontal line O X indicate by their distance from the point O the magnitude of the tangents of those respective angles. But the currents are also proportional to the tangents of the angles; therefore the distances from O along O X are proportional to the currents which would cause the corresponding angles of deflection, and we may therefore regard the line O X as marked off in strengths of current, proportional to the currents required to produce those angles of deflection. Now, if we mark off a vertical scale of degrees from the point O, the points on the tangent curve may be found in the following manner:—Lines drawn vertically from the current divisions on the horizontal ordinate must each intersect a horizontal line drawn from its respective angle on the vertical ordinates, and the points of intersection so obtained are actual points on the tangent curve. Thus, where the perpendicular from A cuts the horizontal from 65 degrees, the point of intersection is one point on the tangent curve. Now, on joining together all these points of intersection, the tangent curve is obtained as shown in the figure. This is, of course, precisely the same thing as a calibration curve of any tangent galvanometer, and it will be of interest to compare the shape of this curve with the preceding actual curves which have been plotted for various indicators not constructed tangentially. For instance, the curve in Fig. 52 is of the same general shape as the tangent curve, while the others in Figs. 48 and 53 are of a different type. A curve may, however, greatly resemble, and yet not accurately be, a tangent curve. It will be noticed that the tangent curve is straight along its first portion from O to about 25 degrees, which means that the angular deflections on a tangent galvanometer are directly proportional to the currents producing them up as far as 25 degrees, beyond which the currents are proportional to the tangents of the angles. And it will also be noticed that as the currents are increased the increase of angular deflection becomes less and less, and that a deflection of 90 degrees could never be produced, since this would require an infinite strength of current. Graphically this last fact would be evident by continuing the drawing of the curve in the same way as shown above, when it would be seen that the curve could never reach the height corresponding to 90 degrees, however far it was produced.

99. *Calibration of an Indicator by Comparison with a Tangent Galvanometer of similar Sensitiveness.*—The current indicator to be calibrated is connected in series to the tangent instrument, an adjustable resistance box, and a few cells. Now, since we have a standard instrument in circuit from whose indications we know at once the ratios of the strengths of current flowing, it is not necessary to know the E.M.F. of the battery used, nor to have any idea of its internal resistance; nor do we require to know the values of the resistances unplugged in the resistance box, as in the previous method (para. 87). In fact, instead of using a resistance box at all, we may improvise a water-resistance in the following way: a piece of glass tubing fixed vertically is corked and sealed at each end after nearly filling with water. Two rigid pieces of copper, brass, or iron wire are pierced through the two corks to form contacts with the water; whatever metal is used, it must be the same for each contact, or an E.M.F. would be set up. The lower contact may be very short and sealed up with wax, as it never need be moved, but the top contact wire must be as long as the tube to allow of its moving up and down, and so to alter the water-resistance between the two wires, or the same thing is very conveniently done [Prof. Ayrton in "Practical Electricity"] by having two plates of zinc placed side by side in a vessel in which is a small quantity of zinc sulphate solution, the resistance between the two plates being altered by increasing or diminishing the distance between their lower edges in the solution. The readings for the curve will then be taken on each instrument for every change in the current, starting with no resistance and adjusting the number of cells to give conveniently large deflections of about 80 degrees on each instrument, and then increasing the resistance step by step, noting the angular deflections on both instruments corresponding to each change.

(*To be continued.*)

PATERSON AND COOPER'S DYNAMO.

We illustrate below two of Messrs. Paterson and Cooper's latest designs of "Phœnix" dynamos. In Fig. 1 the magnet

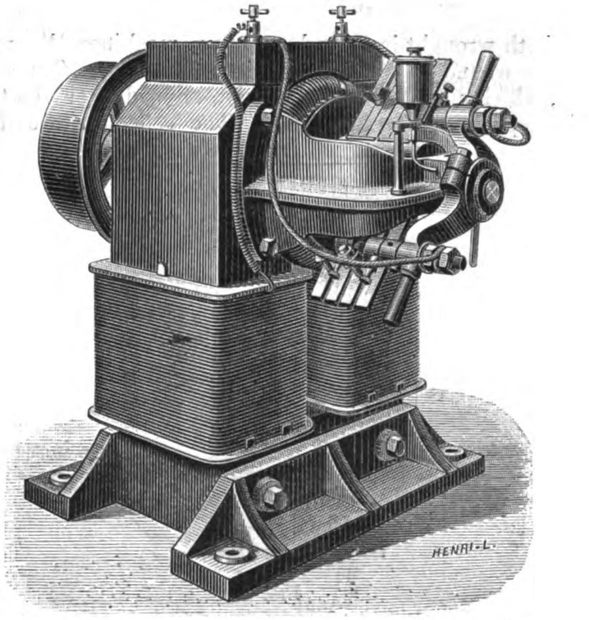

FIG. 1.

consists of a solid wrought-iron horseshoe forging, machined all over and bored out for the armature. Two cast-iron angle pieces are bolted one on each side of the yoke, to form the foundation plate of the machine and to take the holding-down bolts. The armature is supported by strong gunmetal brackets bolted to the magnets, as shown. Without sacrificing stability, it is obvious that this construction ensures a machine having for its output light weight and at the same time high efficiency. In some cases the makers dispense with the solid forging and cast a yoke and angle pieces together. The magnet limbs in such cases are bolted to the yoke, and the cross section of the latter is made at least 1·5 times that of the wrought-iron limbs, in order that the induction may not be throttled.

Fig. 2 shows the S type of machine, in which the magnet is made of cast iron. The yoke is formed by the bed-plate, which is thickened up (as shown in the section, Fig. 3). Casting the magnet limbs connected by the thin piece A not only facilitates greatly the tooling, but, in consequence of the area of the joint being large, the magnetic resistance is diminished. The armature is here supported by cast-iron brackets bolted to the bed-plates, the bearings being of white metal. The smallest machine of the S type supplies ten 16 candle-power lamps, and the largest made up to the present supplies 850 lamps at 600 revolutions per minute.

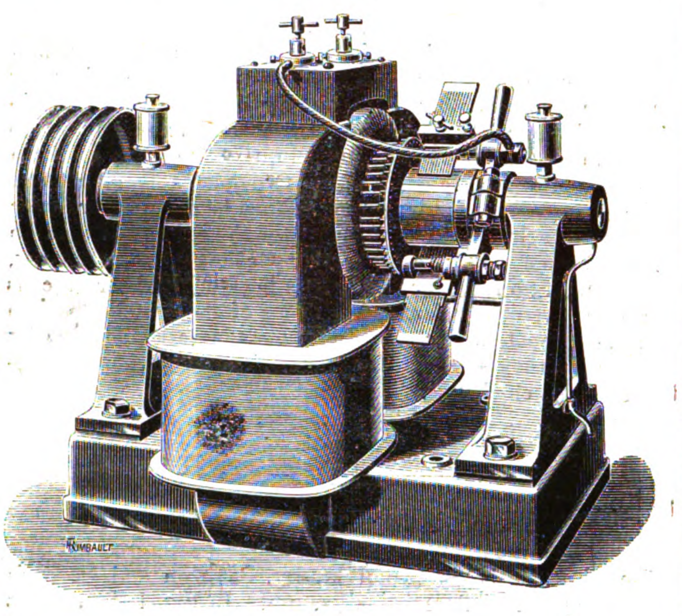

FIG. 2.

In both wrought-iron and cast-iron machines the magnet coils are wound on separate bobbins of sheet iron flanged with brass, which are, after being wound, slipped over the tops of their respective limbs into place. The collectors are of hard

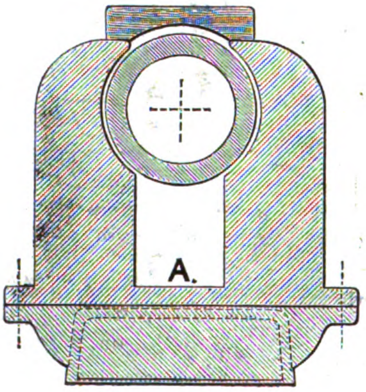

FIG. 3.

drawn copper insulated with mica, and the brushes are of soft brass wire.

DETNISIENSKI'S AUTOMATIC FIRE ALARM.

During the recent discussion at the Society of Telegraph-Engineers on Mr. R. Von Treuenfeld's paper on "Fire Alarms," it was pointed out by Captain Shaw that the system of automatic fire alarms possesses an inherent disadvantage, arising from the fact that unless a large number of these appliances are placed in all parts of the building, and several even in the same room, it is quite possible that a fire may arrive at serious proportions before the temperature of any one of the alarms rises sufficiently high to bring it into action. This difficulty appears to us to be overcome by a device of a very simple and ingenious character, which is described in a recent number of the Moscow *Technik*.

Two types of this apparatus are represented in Figs. 1 and 2. In Fig. 1 is seen an iron or copper tube, closed at one end, and containing a small quantity of mercury; at the lower or closed end of the tube is a projection which terminates in a ring encircling a pivot C, round which it can turn quite freely. The open end of the tube is closed with a stopper of wood or india-rubber, through which pass two insulated wires A and B. A piece of string, D, is attached to this end of the tube, by which it is held up in the position shown in the figure. The string D passes upwards to the ceiling, and from thence it is carried along the cornice around the room, while at any particular point it may be brought down to the level of the floor, or carried along the ceiling, so as to pass, for instance, over a gas bracket; finally it is terminated at some fixed point.

Now, when a fire breaks out, no matter in what part of the room it may arise, the string is sure to be burnt through at a very early stage. Immediately this happens the tube turns round the pivot, and the mercury closes the contact between A and B.

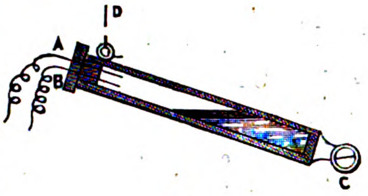

FIG. 1.

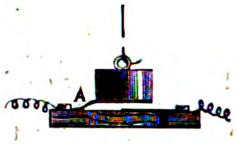

FIG. 2.

Fig. 2 shows another form of the apparatus. To a projecting bracket are attached two copper plates, A and B. A is separated from B by being bent, as shown in the figure. Over this bracket is a heavy weight, suspended as before by a cord passing all round the room. When the cord is destroyed by fire the weight falls, brings A and B together, and closes the circuit.

The apparatus is the invention of M. Detnisienski, and it certainly appears to meet the requirements of an automatic fire alarm in a very high degree.

ELECTRIC LAUNCHES AT THE BOAT RACE.

The boat race of 1888 may be remembered as the first in which the electric launch has made its appearance on the river. In a few years we shall doubtless find that for purposes of pleasure the steam launch will have well-nigh disappeared, for no one who has once experienced the comfort, pleasure, and handiness of an electric launch will ever again be content with its noisy and dirty predecessor. It should therefore be welcome news, not only to electricians but to all who are interested in the river, to learn that Messrs. Immisch are making active preparations for the establishment of floating charging stations on the Thames. The first of these will probably be stationed in the neighbourhood of Kew. A roomy hulk has been purchased, a 20 horse-power Fowler engine (under-type with loco-boiler) has been put aboard, and the dynamo will shortly be ready. Messrs. Immisch intend to place a fleet of launches on the river for hire, and will also charge accumulators at a fixed tariff. Every one must hope that this movement, which has been undertaken with the foresight and energy characteristic of the firm, will ultimately prove a real success.

On Saturday last the hulk in question was moored off Mortlake a little below the winning post, and a large party of electrical and other friends of the firm, who had been invited to witness the boat race, were on board. Before we had long been afloat, the look-out man espied a small craft making rapid headway up stream without sail, or oar, or other visible means of propulsion. As soon as she became visible to the naked eye, this proved to be the "Lady Cooper," flying the flag of the Electrical Power Storage Company. A vigorous

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"ahoy!" soon brought her alongside, and complimentary visits were exchanged by officers and crews of each craft. We shall, however, reserve our detailed description of the "Lady Cooper" until next week, when we hope to have illustrations ready. It will be sufficient now to say that she is the largest and best-appointed electric launch which is yet afloat, and that she made her trial trip only the day before the boat race; so hurriedly, in fact, was she completed, that the proper screw not being ready she was provided for the occasion with a screw of smaller diameter, which happened to be at hand. But notwithstanding this disadvantage she was able to make no less than eleven knots per hour on the tideway.

When the race was over we bade farewell to the party on board Messrs. Immisch's "Charging Station," and embarked on the "Lady Cooper" for the return journey. The party were all in high spirits, and on the way down stream several scratch races with steam launches were indulged in, with results that led to the conclusion that the "Lady Cooper" could hold her own with any craft of the same size afloat on the river. After a very merry and somewhat adventurous voyage, the party broke up at the Temple Pier, with many expressions of satisfaction at the evident success of the latest venture of the E.P.S. Company, while the launch continued her journey to Millwall. We may add that the launch is named after Lady Cooper, wife of Sir Daniel Cooper, Chairman of the E.P.S. Company.

A SOUND RECEIVER FOR SUBMARINE TELEGRAPH LINES.

A method of receiving signals on submarine cable lines by means of the telephone, or rather, by a pair of telephones, has lately been proposed by M. Ader.* The author thinks it will be applicable wherever the mirror or Thomson recorder

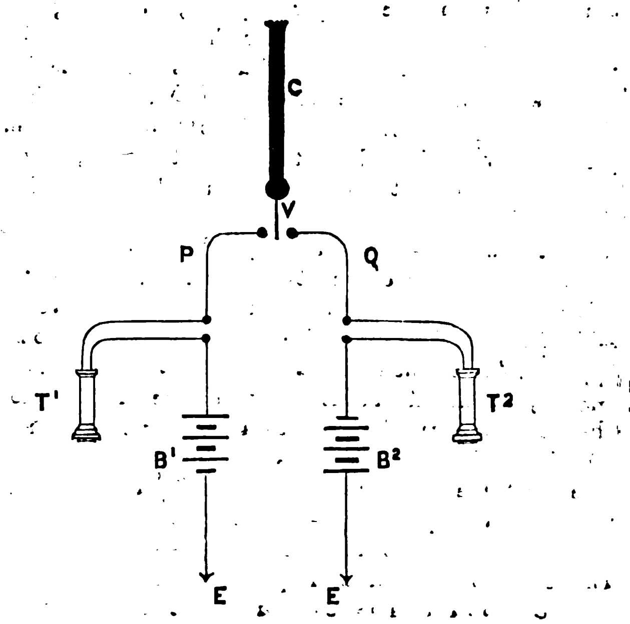

Fig. I.

is in use. Whether M. Ader has had an opportunity of actually carrying out the experiment which he describes does not appear; but the ingenuity of the idea will be appreciated, even if it should not prove to be of practical utility.

If a telephone be placed directly in circuit with a submarine cable working a mirror or a recorder no sound whatever is heard, because the rate of variation of the current is too slow to affect the diaphragm sensibly to the ear. And if an electrical or mechanical vibrator be introduced into the circuit, keeping all other conditions as before, we should simply hear the hum of the vibrator, and this would be unaffected by the signals. Suppose, however, that we had two independent telephones, and that the positive and negative currents received upon the cable were directed each into a separate telephone receiver, we should clearly have at least the basis of a method of reading the message by sound.

M. Ader seeks to develop this idea in the following way. In the diagram* (Fig. 1) C is the cable, which is connected with a vibrating tongue, V. The tongue is kept in rapid vibration by means of some quite independent electrical or mechanical device, which is not shown in the figure. The function of the vibrator is two-fold, first to interrupt the current so as to produce sound in the telephone; secondly, to direct the current alternately into the branch P to the left, and into the branch Q to the right, which contain the telephones T_1 and T_2 respectively. This distribution is effected quite independently of the direction of the current in the cable at the moment. But each of the branches P and Q contains also a battery B_1 and B_2, B_1 having its positive pole and B_2 its negative pole to earth, or *vice versa*. Now, suppose that a positive current is received upon the cable. The vibrator makes, it may be, a dozen or twenty contacts on either side while this current lasts, but if the strength of the batteries be suitably adjusted the telephone T_2 alone responds to the signal, the battery current being added to that received over the line. The telephone T_1 is mute, because the current is neutralised in this circuit by that of the battery. The battery current may, of course, be adjusted by the insertion of suitable resistances.

The weak point of this device evidently lies in the impossibility of adjusting the batteries B_1 and B_2, so as to balance the continuously varying currents received over the cable. But, on the other hand, it is quite possible, and even, we think, probable, that an operator would soon become sufficiently expert to read by gradation of sound, although neither telephone was absolutely silent.

M. Ader thinks that owing to the sensibility of the telephone it would be possible to work cables on this principle with smaller cores, and thus effect considerable economies in the construction of new lines.

* *Comptes Rendus*, March 19th, 1888.

* It should be stated that the diagram is not in the original paper, but we have added it for the sake of clearness.

BOOK RECEIVED.

"Sell's Dictionary of the World's Press, and Advertisers' Reference Book, 1888." (Sell's Advertising Agency, 167 and 168, Fleet-street, E.C.)

MEETINGS OF SCIENTIFIC SOCIETIES.

SATURDAY, March 31st.

GEOLOGISTS' ASSOCIATION.

2:30 p.m. Visit to the British Museum (Natural History) Cromwell-road, London.

MONDAY, April 2nd.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

THURSDAY, April 5th.

CHEMICAL SOCIETY.

8 p.m. Meeting.

FRIDAY, April 6th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at the St. James's Hall Restaurant.

*** Particulars of meetings to be held or papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

ORIENTAL TELEPHONE COMPANY.—The Directors of this Company on Wednesday decided to recommend a dividend for the year ending 31st December last of 2¼ per cent., free of income-tax, on the paid-up capital of the Company other than the vendors' shares.

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The Electrician.

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"LIGHTNING AND THUNDERBOLTS."

If the amount of space afforded by the daily press to reporting and commenting on the Meteorological Society's meeting last week may be taken as a measure of popular interest in its proceedings, the President and Secretary have reason to be gratified with their choice of subjects for discourse on that occasion. With that professional felicity which characterises the newspaper reporter, the doings of the evening appeared next day under the attractive head line of "Lightning and Thunderbolts," and as one of the lecturers dealt with atmospheric electricity, and the other with thunderbolts, whilst the exhibition on view in the premises was intended to illustrate both, we have felt that we cannot do better than adopt this imposing title for the few observations we have to offer on the incident taken as a whole—that is to say, the papers, the exhibition, and the newspaper comments thereon. We are led to adopt this course by the further consideration that whatever may be said of the exhibition—which, besides being "extremely interesting," as the newspapers described it who did not understand it, was useful and instructive to the experts who did—the lectures were addressed to a popular rather than to a scientific audience; and it is therefore rather curious to note what the popular audience thinks about them. The president even apologised—needlessly, it seems to us—for his mercilessly scientific treatment of atmospheric electricity. That our knowledge of atmospheric electricity is making progress our own columns continue to bear testimony, but that Dr. MARCET was justified in conveying the impression—which his paper certainly did convey—that there is little left to learn, we are certainly not prepared to admit.

It is true that we possess a natural theory of the *modus operandi* by which the potential of a rain-cloud may rapidly rise to a tremendously high value, but the fundamental question of the ultimate origin of the charge is still in dispute—or, since no one who is really competent to form an opinion cares to dogmatise on the question, we should rather say is still under discussion. To take only one other outstanding problem, the formation of hail may or may not be primarily due to an electrical cause. Prof. COLLADON has a theory on the sub-

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ject, which was described by Dr. MARCET as follows :—"The heavy rainfall preceding a hail shower carries a mass of air before it and causes a strong downward wind; this is obviously attended with a powerful suction or a partial vacuum in the upper clouds. At once a fall of temperature takes place which causes a condensation of moisture into frozen particles. The down drift from the shower of rain heralding a hail storm is productive, according to M. COLLADON, of upward and side currents of air which drive up the sleet and tear the rain cloud into a number of separate cloud masses, each of them powerfully electrified; the particles of frozen moisture are now attracted and repelled between these cold clouds while driven about by the wind, thus increasing rapidly in size until they become so heavy that they fall to the ground in the form of hail."

A very ingenious suggestion on this subject was made some little time ago by Prof. G. GOVI, and although it has since been withdrawn by its author, owing to the negative results of experiments which he has tried, it is yet of sufficient interest to be alluded to. Prof. GOVI supposed that aqueous vapour might exist in still air in the higher regions of the atmosphere at a temperature under which its condition would resemble that of a solution of salt in the super-saturated state. It is well known that a sudden shock, or, better still, a small crystal dropped into such a solution, will instantly bring about crystallisation. In the same way Prof. GOVI suggested that an electrical discharge might cause the sudden congelation of the vapour in the higher regions of the atmosphere. But on putting this supposition to the test of experiment by causing a powerful electrical discharge to pass through a super-saturated solution of sulphate of soda in a sealed glass vessel, contrary to reasonable expectation it was found that the disturbance *did not* set up crystallisation. We think, however, that Prof. GOVI's ingenious suggestion will bear further investigation before being finally discarded.

Returning to Dr. MARCET's paper, whatever may have been its author's intention, we certainly find that the impression produced upon the public mind, as represented by the columns of the daily press, was that which we have already intimated, namely, that very little is left to be learnt in this department of science. For instance, the *Standard* leader writer talks as follows: —"But whatever conflict of opinion may be permissible on this point [*i.e.*, the cause of waterspouts], it is clear that none is allowable in regard to the Aurora Borealis Australis" [*sic*]. If the writer had intended to say that the known data were insufficient to form the basis of any reasonable difference of opinion we should have been inclined to agree with him. But this is not his view, and after retailing a crude explanation (which, by-the-bye, Dr. MARCET only quoted as being "generally considered" probable) the article finishes up as follows:—"And thus the electrician deprives us of the last fragment of romance which clung to the most picturesque of Northern atmospheric phenomena." Against this idea in general—an idea which runs all through the article, and which is still too widely prevalent, that science is fatal to mystery, and, therefore, in a large degree to the poetry of life—it is, perhaps, not worth while here to make any serious protest. As a matter of fact, both romance and poetry have gone on increasing side by side with the advances of science, the beauty, the mystery and majesty of natural phenomena being none the less inspiring for being better understood.

Turning now to Mr. SYMONS' thunderbolt paper (which our readers have already had an opportunity of reading), we find an excellent *exposé* of a popular superstition, which, although of an extremely natural and excusable character, ought to have been exploded long ago. Our readers have probably already enjoyed a good laugh over the clinkers, and sandstone-nodules, and lumps of brick and coal which have done duty at various times as thunderbolts. Mr. SYMONS mentioned, by-the-bye, that some of the clinker-thunderbolts which fell from the Kentish Town fire engines were sold at 10s. and 12s. a-piece. But although the purchasers must be admitted in these cases to have had a very dear bargain, yet certain other cases cited by Mr. SYMONS suggest the idea that the track of a reputed thunderbolt—that is to say, the hole which is sometimes dug in the soil by a lightning discharge—will often well repay exploration. In one such case an antique cannon ball was thus discovered, and in another case—not, however, mentioned in the paper—an ancient British celt came to light, Now it seems reasonable to assume that the existence of these metallic bodies buried under the soil had something to do with determining the path of the lightning. And it is also clear that a buried treasure would be as efficient for the purpose as a celt or a cannon ball. Hence, lightning tracks in the soil should *always* be dug up by the first finder. *Verb. sap.*

THE ELECTROLYSIS OF COPPER SULPHATE IN STANDARDISING ELECTRICAL INSTRUMENTS.*

BY A. W. MEIKLE (Thomson Experimental Scholar).

Owing to the great increase in the use of electricity in recent years, and the consequent importance of having accurate measuring instruments, it is necessary that electricians should have some accurate means whereby they may have their standard instruments readily and cheaply checked from time to time. Much might be said for a national recognition of this fact by the establishment of a system of electrical standards, just as we now have national standards of length, weight, &c.; but such a subject is beyond the province of this paper, in which I propose to give a description of the electrolysis of copper sulphate, which has been employed for standardising purposes in the Physical Laboratory of Glasgow University for the last two years, with the most satisfactory results.

A paper communicated by Mr. Thomas Gray to the *Phil. Mag.* for November, 1886, dealt with the question of the reliableness of copper electrolysis as compared with silver. The conclusion drawn from the investigation described in that paper was, that while silver in the hands of a trained experimenter left nothing to be desired in point of accuracy, still it is open to the objection that it is very costly where large currents are used, and requires great care in making the experiments. Copper, on the other hand, has the advantage of simplicity in manipulation, and where attention is given to a few necessary precautions great accuracy can be obtained. As an example of the difficulties in the use of silver I may mention that the deposit, which is always crystalline in form, requires careful handling, in order to prevent loss in drying or weighing, and in order to get it thoroughly adherent to the plate the area of the cathode or gain plate should never be less than 200 or more than 400 sq. cms. per ampere. With copper the deposits for areas exceeding 20 sq. cms. per ampere is thoroughly adherent to the plate, of which, indeed, it forms an integral part. Thus, in making an electrolysis of copper sulphate for 100 amperes, a current density of 1 ampere to 50 sq. cms. would give excellent results, and the total area of gain plates would only be 5,000 sq. cms., while were silver used the area would require to be from 20,000 to 30,000 sq. cms.

One disadvantage which copper has is its readiness to oxidise when exposed to the air, more especially when being taken out of the sulphate of copper solution, but if the mode of cleaning and drying the plates, both before and after electrolytic action, which is described in this paper, be employed, this difficulty is easily overcome. I have kept plates for a week after being treated in this manner without being able to observe any change of weight, as indicated by a chemical balance which is sensitive to $\frac{1}{10000}$ of a gramme.

Another point which has to be taken into account is the fact that the plates lose weight in the solution at a rate varying with the

* Paper read before the Physical Society of Glasgow University, January 27th.

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area they expose to the action of the acid which is contained in all electrolytic solutions of sulphate of copper capable of giving reliable results. This question was gone into very fully by Mr. Gray about two years ago, and the results are given in his paper on electrolysis which is referred to above. It has again been gone into when making some experiments on the effect of temperature on the loss of weight of the plates in the solution. The results of these experiments, which were made by passing the current through 10 cells in series each of which had a different area of plate, is to confirm the experiments made by Mr. Gray, and to show that the amount of variation from the true electro-chemical equivalent of copper due to differences of current density can be allowed for with great accuracy. Before describing particularly the results of these experiments, it may be well to refer briefly to the apparatus used.

ELECTROLYTIC CELLS.

The electrolytic cell found most convenient for small currents consists of a round glass jar nearly filled with sulphate of copper solution, into which three vertical plates, with their services parallel and about 15 mm. apart, are held by means of rigid platinoid clips. The two outside clips are joined together, and the plates held in them are the anodes or loss plates (see Fig. 1). Two loss plates are always put into each cell, one on each side of the gain plate, so that the gain plate may receive a uniform deposit on each side. The centre clip, which is well insulated from the two others, holds the cathode or gain plate. The clips for holding the gain plates are formed of straight pieces of No. 6 platinoid wire, about 6in. long, a portion of which, about 4in. long, is filed flat, and on to this another piece of platinoid, bent so as to form a powerful spring, is soldered at *a*, so that the two ends of the pieces form a firm contact at *b* (Fig. 1). A binding screw for fixing on the electrode is screwed on to the other end at *c*. Several of the clips so formed are firmly clamped on to a rectangular wooden frame by screwing a strip of wood down on the top of them, the portion of the clip between the wood being well insulated by being covered by a piece of thick india-rubber tube.

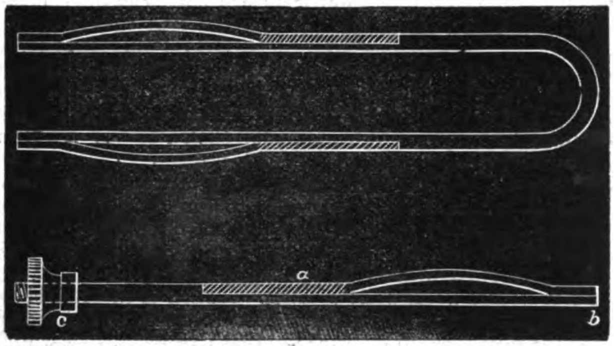

FIG. 1.

The clips for holding the loss plates are formed in the same manner as the gain plates, but are made in pairs by bending a piece of No. 6 platinoid wire into the shape of a U, with about three centimetres between its ends, and then soldering on the springs as already described.

These clips are insulated and fixed on to the frame on the opposite side from the single clips, so that the end of the latter comes just between the two ends of the former, as shown in Fig. 2. A flexible, covered copper wire, of convenient length to enable the cells to be joined in series if desired, is permanently soldered on to the bend of the double clips. This mode of placing several sets of clips on a wooden stand is found very convenient, as the plates can readily be adjusted in their position, or taken out without disturbing any of the other arrangements.

This form of clip suits very well for currents up to about fifteen amperes by joining the cells in series or parallel, as may be necessary. In using electrolysis for small currents up to two amperes, it is advisable to use two or even three cells in series, as with small deposits a check is thus obtained on the weighings, or any defect in an individual cell. With currents from three to 15 amperes I prefer still to use this form of clip, and a sufficient number of cells in parallel, each having gain plates of about 130 sq. cms. in area, so that the plates, owing to their comparative lightness, may be weighed on the chemical balance—the additional number of weighings being more than compensated for by the additional accuracy obtained.

For currents such as are used in standardising a deca or hecto-ampere balance, owing to the large amount of copper deposited, such delicate weighing is not necessary, and a balance sensitive to about two milligrammes may be used; but even were an error of five milligrammes made in weighing the plates of an electrolysis for 50 amperes continued for one hour the error would only amount to about $\frac{1}{100}$th per cent. For high currents, such as these, a large earthenware cell is used, which is shown in Figs. 3 and 4. A wooden frame is fitted on to the

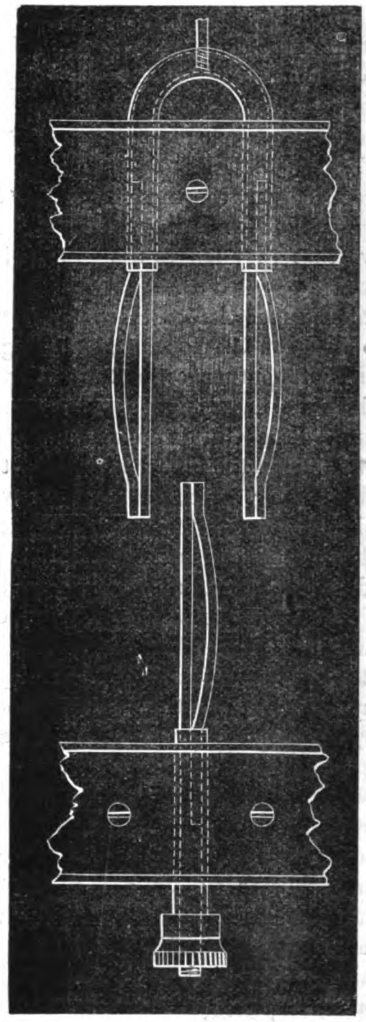

FIG. 2.

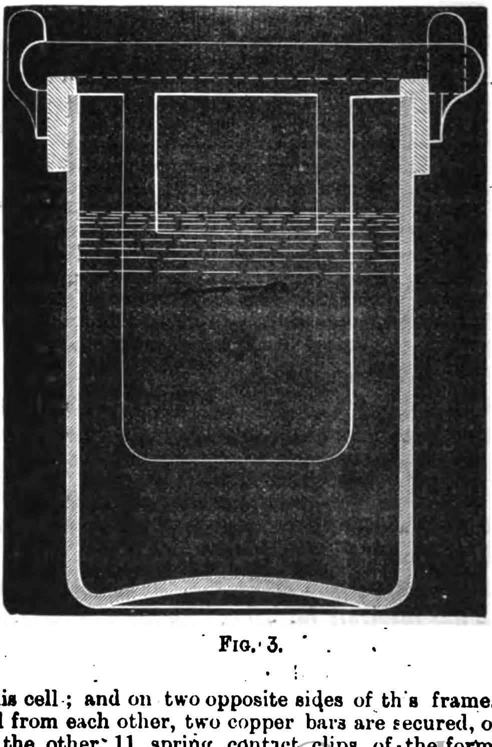

FIG. 3.

top of this cell; and on two opposite sides of this frame, and well insulated from each other, two copper bars are secured, one having 10 and the other 11 spring contact clips of the form shown in Fig. 5. The plates for this cell are made of sheets of copper, each of

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which has a rigid strip of copper soldered to its top edge, and projecting about two inches on each side of the plate. On putting the plates into the cell one end of this strip fits into a clip and the other rests in a vulcanite notch on the other side of the cell. Each of the plates when in position exposes a surface of 1,100 square cms. to electrolytic action, so by putting in the proper number of plates the cell can be used for currents up to 200 amperes. The plates and clips are so arranged that one gain plate comes between two loss plates, and the latter always exceed the former in number by one. As the plates, when all are put in, are very close together, two glass tubes bent so as to form U's, and long enough to reach to the bottom of the cell, are hung over each loss plate to prevent any danger of the plates touching. Two flexible electrodes

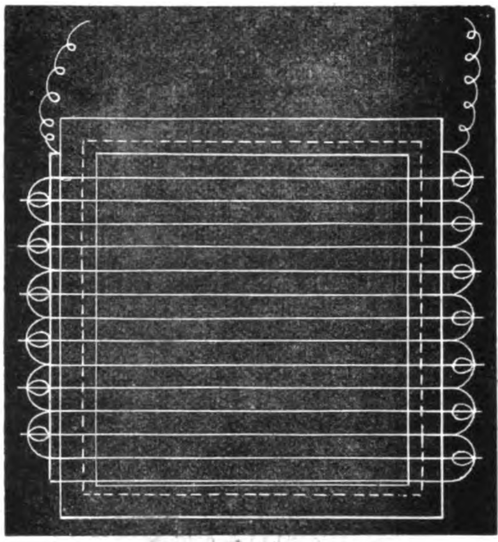

FIG. 4.

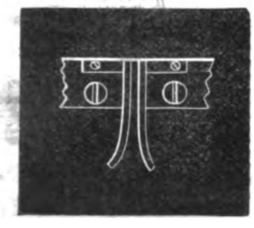

FIG. 5.

suitable for dipping into mercury cups are attached to the bars carrying the clips.

The Solution for the Electrolytic Cells.

The solution used is made by dissolving commercial copper sulphate in pure water as it comes from the Glasgow Corporation's water pipes until a density of from 1·15 to 1·18 is obtained, and then adding 1 per cent. of free sulphuric acid. For all the experiments mentioned in this paper the solution used has been of a uniform density of 1·175, but it has been found that a variation in density from 1·1 to 2 makes no difference in the nature or quantity of the deposit. With solutions made up as described perfectly accordant results have invariably been obtained. The solution should not be used too often, as the acid is after a time exhausted by action with the plates, and it has been found from experience that unless the solution is decidedly acid the plates are oxidised in the solution, and very irregular results are obtained, which are quite valueless for accurate standardising. The table of curves (A) shows very clearly the difference between results obtained from solutions which have free acid and those which have not. The five curves are taken from experiments made with ten cells in series and different areas of gain plate in each. The abscissæ are areas of gain plates in square centimetres per ampere, and the ordinates are deposits in grammes. It will at once be observed that the curves I., II., and III. are exactly similar in form. Curve I. is the mean of about 12 experiments made with free acid in the solution. Curves II. and III. are from two single experiments also, with about 1 per cent. of free acid in the solution. Curve IV. is taken from an experiment made with solution which had been used too often, and the results are irregular owing to oxidation of the plates in the solution. Curve V. shows the results obtained from a solution in which some copper oxide had been dissolved, so as to withdraw all the free acid. The gain plates were found to be very much oxidised when taken out of the solution, and had a dark brown colour instead of the bright metallic surface which they have when taken from a solution which contains acid.

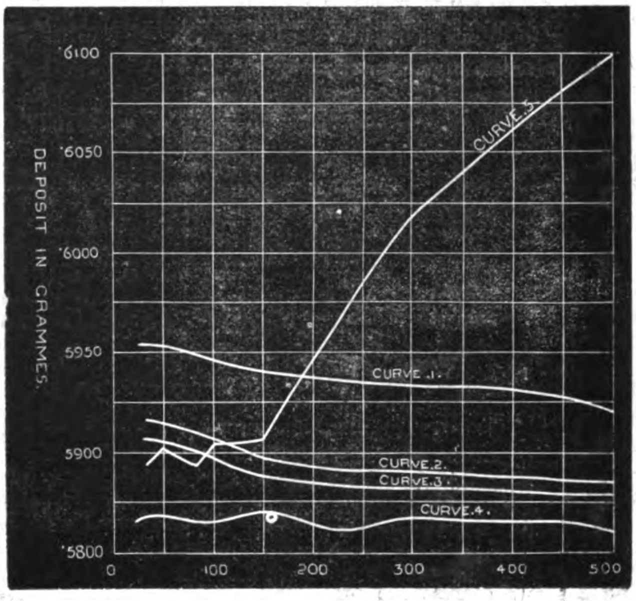

DIAGRAM I.

Preparation of Plates.

The gain plates used are made from ordinary high conductivity sheet copper about $\frac{1}{10}$ths of a millimetre in thickness. For the smaller cells they are cut in the shape shown in Fig. 6, as this form of plate, owing to the flexible tongue, is very easy to adjust in its position, and when in use the whole plate is immersed in the solution except the narrow tongue necessary to hold the plate between the contact clips, thus leaving a very small area exposed to any possible oxidation by the atmosphere. This form of plate has also the advantage that the area exposed to electrolytic action can be got at once, or may be permanently stamped upon the tongue, and the proper equivalent for the current density can be taken without having to measure the area covered by the deposit. The edges of the plate are all smoothed, and the corners rounded off, as the deposit is apt to form on any rough edges, especially if a high current density is being used, or if the current is being run for a long time. When this has taken place, the plates, owing to the roughness of the surface, are not so readily dried, and the risk of oxidation is increased, as is also the risk of losing part of the deposit should the plate accidentally strike against any object. The surface of the plates is burnished with fine glass paper until perfectly bright and smooth, then rubbed with a piece of clean cloth, and finally wiped gently with a piece of silk to remove any shreds, after which they are ready for weighing. Another plan, which has been successfully employed, is to polish the plate with

FIG. 6.

silver sand and water, to which a few drops of sulphuric acid were sometimes added. The plates are then washed in clean water to remove the sand, and placed in a vessel containing pure water, with a little sulphuric acid in it to remove any oxide which may have formed during the washing. From this they are taken one at a time, quickly dipped in fresh water, and dried immediately on clean white blotting paper, then held before a fire to remove any trace of

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moisture which might remain. The method which has been found most convenient, however, is to place a sheet of No. 1 glass paper on a wooden roller and spin it in a turning lathe, holding the plate against it by a pad. When the plates have been burnished by this method, the sand paper, which is only held on the roller by two springs, is removed, and a piece of rough cloth put on instead. On this cloth the plates receive a final polish to remove grains of sand, are then wiped with a piece of silk as in the first method, after which they are ready for weighing. Care should be taken never to touch the portion of the plate intended for immersion in the cell with the fingers, as by so doing the surface is spoiled for a deposit and the mark of the finger is seen distinctly after the electrolytic action.

Loss plates are also made from high conductivity copper, but from a thicker sheet, so that they may last for some time. No great trouble need be taken with them, except to see that they are not put into the liquid when badly oxidised, in which case the free acid in the solution unites with the oxide on the plate, and the solution suffers in consequence, as I have already explained. For this reason, too, the loss plates should never be left in the solution when not in use, but should be taken out and placed in water with a few drops of H_2SO_4 added, or, if they are not likely to be required again for some time, they should be dried and put past.

Size of Plates.

Loss plates should never have an area of less than 40 sq. cms. per ampere. If the area is much less than that the resistance of the cell becomes high and variable owing to the formation of copper oxide on the plate, and if it be made very small gas is given off at its surface, making it impossible to keep the current steady, and giving a result of no value for accurate standardising. The gain plates should never expose a surface of less than 20 sq. cms. per ampere. When too high a current density is used the deposit is not so adherent to the plate, and a portion may be lost in washing and drying. It is always best to use an area of from 50 to 100 sq. cms. per ampere, using the larger area for currents which are intended to run for some time. By doing so any little roughness round the edges is avoided, and in consequence the plates are easier to dry.

As already mentioned at the beginning of the paper, the amount of copper deposited by a given current varies with the area of the plate exposed to the corrosive influence of the free acid in the solution of copper sulphate. This variation is not the same as it would be were no current running; in reality it is less, from which it would seem that the current exercised some protecting power. This subject has been very fully investigated in the physical laboratory, as also the effect of temperature on the rate of loss, and the results of the experiments are shown in the Table of Curves No. II., and the two tables of numbers which I shall speak of presently.

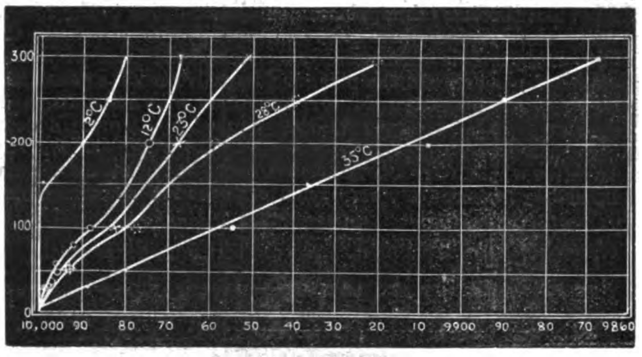

Diagram II.

The experiments were made with ten cells in series, all carefully insulated from each other, and each cell having a different area of gain plate, the extreme range being from about 30 to 50 sq. cms. per ampere. The solution used in all cases was 1·17 in density, with 1 per cent. of H_2SO_4 added. From former experiments described in Mr. Gray's paper on electrolysis before mentioned, no difference could be observed in the amount or appearance of deposits from solutions containing percentages of acid varying from ½ per cent. to 5 per cent. at a temperature of about 12deg. C.; but owing to the very rapid consumption of the free acid in the solution at the higher temperatures, fresh solution was used each time.

The curves show the results obtained for different areas of cathode or gain plate, and each curve is for a different temperature between 20deg. C. and 35deg. C. It will be observed that they all converge rapidly towards the point of crossing, which shows that the same deposit would be had at all temperatures were it only possible to use a small enough area of gain plate. The curves were produced to cross the line of ordinates, and the point of crossing was taken as 10,000 and the other points reduced to correspond, so as to render percentage corrections easy for different current densities. The ordinates are therefore numbers proportional to the weight of copper deposited in grammes, while the abscissæ are areas of gain plate in square centimetres per ampere.

The curve for 2deg. C. is the mean of three experiments, which were in very close agreement. It is rather curious that for a range of current density almost up to 130 sq. cms. per ampere there is no effect made by variations in the area of gain plates, but the same tendency is shown in the curves for 12deg. C., 23deg. C., and 28deg. C., although to a much smaller extent. The curve for 12deg. C. is the mean of a large number of experiments which were in very good agreement among themselves. It is the same curve which is shown as the mean curve in the first table, but on a different scale. The effect of temperature from 10deg. to 15deg. C., which is about the ordinary range of temperature in the Physical Laboratory of Glasgow University, is very small and may be neglected. Indeed, with a gain plate of 50 sq. cms. per ampere, the total variation in the corrected equivalents for 12deg. and 28deg. C. is only about $\frac{1}{18}$ per cent. The curves for 23deg. C. and 28deg. C. are two single experiments, while the curve for 35deg. C. is the mean of two experiments which were in good agreement with each other. A glance at the curves will show how important the question of temperature becomes at the high points. In countries where 28deg. and 35deg. C. were normal temperatures a very careful allowance would require to be made for any variation. The Table No. I. gives the numbers from which the second table of curves is taken, and Table No. II. gives the corrected electro-chemical equivalents, as calculated from these numbers for different current densities from 1 ampere to 50 sq. cms. up to 1 ampere to 300 sq. cms.

Table I.

Area of cathode in square centimetres per ampere of current.	Temperature, 2° C.	Temperature, 12° C.	Temperature, 23° C.	Temperature, 28° C.	Temperature, 35° C.
50	10000	9996·4	9995	9993·5	9980·5
100	10000	9987	9983	9979·5	9958
150	9998	9979·5	9974	9969·6	9935
200	9990	9973	9966·6	99[illegible]7·5	9912
250	9984	997[illegible]	9959·5	9939·3	9890
300	9980	9968·5	9952	9920	9868·5
400	......	9961	—	—	—
500	......	9949	—	—	—

Table II.

Area of cathode in square centimetres per ampere of current.	Temperature, 2° C.	Temperature, 12° C.	Temperature, 23° C.	Temperature, 28° C.	Temperature, 35° C.
50	·0003283	·0003287	·0003285	·0003286	·0003282
100	·0003288	·0003284	·0003283	·0003281	·0003274
150	·0003287	·0003281	·0003280	·0003278	·0003267
200	·0003285	·0003279	·0003277	·00032[illegible]4	·0003259
250	·0003283	·0003278	·0003275	·0003263	·0003252
300	·000328[illegible]	·0003278	·000327[illegible]	·00032[illegible]2	·0003245

Standardising Arrangements.

The arrangements for standardising consist, as shown in the diagrams, in joining in series a constant battery, the instrument to be standardised, the electrolytic cells, and a variable resistance. Care should always be taken to join the instrument directly on to the electrolytic cells and have that portion of the circuit well insulated, so as to be sure that the instrument is recording the exact amount of current which is going through the cells.

The simplest form of arrangement is shown in Fig. 7 and is suitable for currents up to ten amperes. The variable resistance used in this case is one of Sir William Thomson's rheostats. For currents up to one ampere a high resistance rheostat of platinoid wire is used, and for currents above that point a large rheostat of stranded copper wire—the potential of the battery being first adjusted to suit the special case. With large currents beyond the carrying power of any rheostat, a conductivity bridge is put in circuit for the purpose of varying the current. This bridge consists of a number of platinoid U's of sufficient length not to heat much with any current which the potential of the battery can send through them. By dipping the two ends of these U's in two parallel mercury troughs any desired conductivity can be put into the circuit. Fig. 8 shows two of the large bridges, one of which is standing in the mercury troughs, while the other is standing on the insulated sides. The large bridges are kept apart by wooden distance pieces, as shown in the figure, while the small ones are supported on strips of wood through their whole length, and are fitted with thick copper ter-

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minal pieces. The copper rheostat before mentioned is joined in parallel to this bridge, and the whole arrangement, as shown in Fig. 9, simply takes the place of the rheostat in the former arrangement. We have found this last arrangement very useful for standardising instruments, as, with the battery power at our disposal, any current up to 500 amperes can be had by continuous

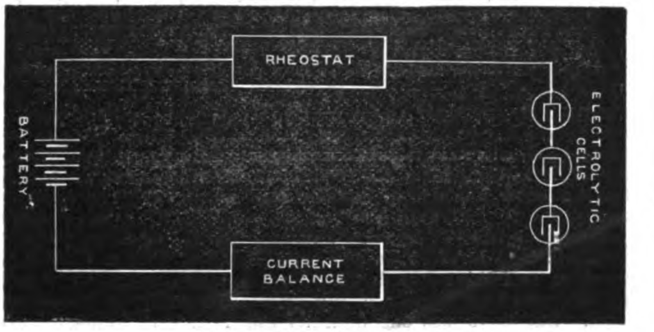

Fig. 7.

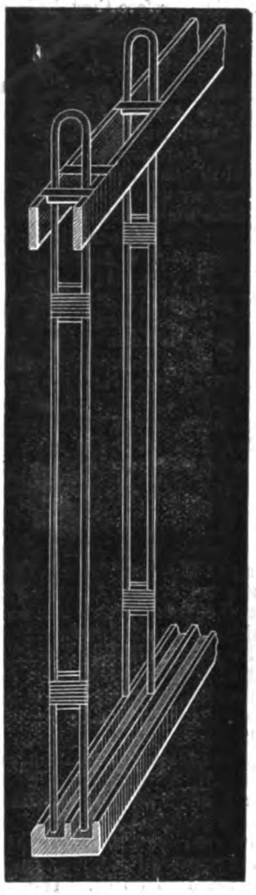

Fig. 8.

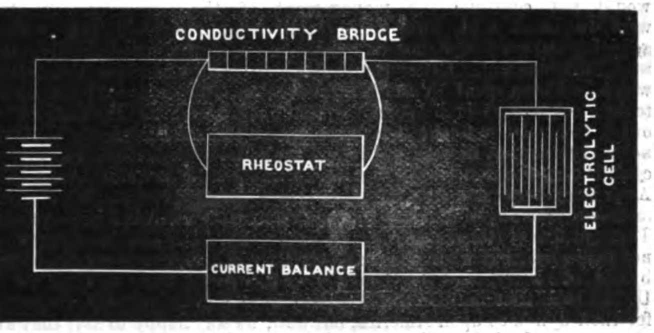

Fig. 9.

steps. The apparatus being arranged as stated above, trial plates of the same area as the gain plates to be used are put into the electrolytic cell, and the current is adjusted to the required reading on the instrument. The circuit is then broken, the trial plates are replaced by the cleaned and weighed gain plates, and current is again made—the exact second being noted on an accurate time keeper. This instrument should be found very nearly to record the desired reading, and should at once be adjusted by turning the rheostat, and by that means be kept steady during the experiment, any error arising from the current not being at the proper strength on starting is very small. As a rule the current, when previously adjusted as above, is, practically speaking, exactly correct when made for the standardising, but should it chance to be even so much as 5 per cent. wrong, an amount which, with the precautions taken, is entirely out of the question, it can easily be set right in at most 10 seconds with apparatus such as has been described, and the whole error on an experiment lasting for one hour would only be about $\frac{1}{140}$ per cent. The current should run until the amount of the deposit will be such that any possible error in weighing, or in starting or stopping the current, is practically speaking eliminated. In breaking the current the exact second is again noted, and the plates quickly removed from the clips, and placed in a glass vessel containing pure water with a few drops of H_2SO_4 added to prevent oxidation. From this they are taken one at a time, dipped in pure water, then dried and weighed as before described in the process of cleaning with silver sand. The jaws of the clip are always opened before putting in or taking out the plates, so that there will be no error due to loss of weight by the friction of the plate with the spring contacts. The zero of the instrument is always carefully carefully noted before and after the experiment.

Standardisings of Sir William Thomson's Standard Current Balances.

As showing the degree of accuracy which can be obtained by the electrolysis of copper sulphate, I shall briefly give the results obtained from the standardisings of Sir William Thomson's Standard Current Balances, the constants for which have been determined by the methods I have described. There are in the Physical Laboratory at the present time seven of these balances, whose measuring range is as follows :—

1.	Hecto-ampere balance;	range		from	20 to 500	amperes.
2.	Deca	,,		,,	,, 4 ,, 100	,,
3.	Ampere	,,		,,	,, 1 ,, 25	,,
4.	Deci-ampere	,,	(a)	,,	,, 2 ,, 50	deci-amperes.
5.	,,	,,	(b)	,,	,, 1 ,, 25	,,
6.	Centi-ampere	,,	(a)	,,	,, 2 ,, 50	centi-amperes.
7.	,,	,,	(b)	,,	,, 1 ,, 25	,,

(1.) The constant of the hecto was first found by electrolysis and the curve calculated from the result of the experiments. On being again checked by electrolysis on December 2, 1886, with its adjusted watts, instead of 100 amperes, as indicated by the instrument, the mean of two experiments gave a current value of 99·996 amperes.

(2.) The deca-ampere balance was standardised by direct comparison with the hecto, and on being checked by electrolysis on February 15, 1887, a result of 49·978 amperes was obtained against a current of 50 amperes read on the instrument. The latest comparison still shows the instrument to be in perfect agreement with the hecto. It has also been twice standardised by electrolysis at intervals of five months, which gave results respectively of $\frac{1}{25}$ per cent. and $\frac{1}{33}$ per cent. too low.

(3.) The constant of the ampere balance was determined by electrolysis, and on afterwards being compared with the deca it showed a variation from that instrument of $\frac{1}{60}$ per cent.

(4.) The constant of deci-ampere balance (*a*) was twice determined by electrolysis, which gave a difference of $\frac{1}{500}$ per cent. between the two standardisings. Its weights were taken by calculation from the result of these experiments, and on being again checked by electrolysis the result showed $\frac{1}{80}$ too large on a current of 4 amperes as read on the balance.

(5.) Deci-ampere balance (*b*) was standardised by direct comparison with centi-ampere balance (*b*), and on being afterwards compared with deci-ampere balance (*a*) showed a variation from that instrument of less than $\frac{1}{100}$ per cent.

(6.) The weights for centi-ampere balance (*a*) were determined by direct comparison with an old and now disused form of deci-ampere meter in June, 1887. Since that date it has been checked at intervals by four separate electrolysis experiments, which gave results respectively of $\frac{1}{14}$ per cent., $\frac{1}{14}$ per cent., $\frac{1}{17}$ per cent., and $\frac{1}{18}$ per cent. too large, which is very satisfactory when the small weight of the deposit is considered. Compared with deci-ampere balance (*b*) this instrument is in absolute agreement.

(7.) The constant of centi-ampere balance (*b*) was determined by direct comparison with centi-ampere balance (*a*), from which, though comparisons have been made from time to time for the last six months, no variation whatever can be observed.

We have thus a chain of instruments measuring from one centi-ampere to 500 amperes, which are, practically speaking, in absolute agreement among themselves, and whose constants have been determined separately, and in many cases by different observers, by the process of electrolysis of copper sulphate described in this paper. This fact not only proves the constancy and accuracy of

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the instruments, but also establishes beyond a doubt the great value of the method of standardising, and that it is equally applicable to currents of all magnitudes.

REVIEWS.

Money, and Money Problems. By Shield Nicholson, M.A., D.Sc. (London and Edinburgh: William Blackwood and Sons, 1888.)

We have read this work with considerable interest, and we have gained from it a clearer insight into the nature and relative importance of the great problems of political economy which are now pressing for solution. The author contrives to make a subject which is usually considered typically arid and repellant not merely tolerable, but positively refreshing from the clearness and simplicity of his style. The first part of the volume is devoted to a non-polemical exposition of the leading principles of the science of Money. The second portion consists of a series of detached essays, some historical and some argumentative. In the latter the author stoutly maintains the superiority of the bi-metallic standard.

THE MAXIM-WESTON ELECTRIC LIGHT COMPANY (LIMITED).

The seventh annual ordinary general meeting of this Company was held at the Cannon-street Hotel on Wednesday, under the presidency of Mr. Hugh Watt, M.P.

The SECRETARY (Mr. John Wright) having read the notice convening the meeting,

The CHAIRMAN proposed the adoption of the report and accounts. He said he did not wish to occupy the time of the meeting unduly, but he thought it might be desirable to enter into certain particulars seeing that the present list of shareholders was entirely new, as compared with that when the present Board, or such of them as remained, undertook the reconstruction of the Company, relieving it from its financial difficulties, and placing it upon, if possible, a sound basis. Having taken office, the facts were disclosed to them that the Company was virtually insolvent, unable to carry on, with no profitable business in hand, with contracts entailing a loss of over £10,000 a year, and the near prospect of liquidation. The share list at that date consisted of less than 1,000 shareholders, and so little faith had they in the future of the electric light, the fever era having passed away, that the new capital subscribed by them to prevent the Company from passing into liquidation amounted to about £550. It was therefore necessary on the part of gentlemen who, looking into matters, thought there was a future for electric lighting, to put their hands in their pockets and, with the assistance of their friends, to find sufficient capital to carry on the Company. That capital was found to wipe off the debts of the old Company, to get rid of the old factory, which cost nearly £1,000 a year, to get rid of city contracts and other unprofitable work entailing a loss, as he had said, of over £10,000 a year, and to put the Company on a sound financial basis. That was four years ago. During that period the original shareholders or those who had since come in had subscribed an amount of capital to the Company, but the bulk of the new capital to enable them to effect new works, to lay down adequate plant to carry on a larger business—all the necessary money had been found by the Board with the exception of £4,000 to £5,000 subscribed by the shareholders to date. The amount which the present Board had returned in dividend had been twice the amount mentioned as having been subscribed by the shareholders. For the previous two years they had paid dividends of 7½ per cent. and 5 per cent., and not unnaturally the shareholders might have expected a dividend in respect of last year's working. He also fully expected up to November last that they would be able to pay a dividend. At that date they had carried out business and had entered into provisional contracts, entitling him to assume that, after paying a dividend of 5 per cent., there would be a considerable balance remaining. The three large contracts—over one of which they had spent, more or less, three months—ultimately fell through, leaving them with a deficiency as compared with the previous year of something like £3,000 in the profits. They had carried through an amount of business, looking to the weight of plant sold, greater than that of the previous year; but they had made that position emanating from sources which did not exist at the beginning of 1887, and which was not based upon commercial principles or on enduring lines—the principle of selling one pound's worth of plant for less than 20s. He then asked the secretary to read a letter which had been received from Mr. Dever relative to certain items in the accounts. Continuing, he said that some two or three days before Mr. Dever's letter had been received the Directors, having arrived at the same conclusion as to bad and doubtful debts, decided on transferring the whole of the balance of profit and loss account, namely, £1,555, to the reserve account, to meet bad and doubtful debts. With respect to the increase in the machinery, plant, and tools account, it had arisen from the fact that they had found that to manufacture the heavier dynamos up to 500 lights would necessitate the putting down of stronger lathes and other machinery. That had been done, and consequently the account had increased. The additional plant put down at the factory had enabled them to manufacture Maxim-Weston and Watt dynamos. He agreed with Mr. Dever that it was desirable that they should add nothing more to patents account, but as long as the present competition was going on and improvements were coming out monthly, unless they permitted themselves to retrograde, they must continue to adopt those improvements. The expenditure incurred had been entailed entirely on Maxim and Weston patents. Reference was made in the report to the fire at the American factory last year, a circumstance which had pretty well deprived the Company of the incandescent lamps for the carrying out of which the Company was originally formed, and without which they had been placed at very decided disadvantages. Their stock of lamps had not been adequate for the supply of their customers, and they had been compelled to tender for Swan lamps. The result was that customers had said, "We thought you had a Weston system, and in coming to you one of the contentions of your Company has always been that you supply a complete system, every detail of which is the invention of one man." With respect to the manufacture of incandescent lamps, a good many present were not aware of the fact that after he joined the Board he went exhaustively into that question, with the result that he found that incandescent lamps were costing them something like 17s. 6d. each, and he believed before he finished his experiments that he arrived at the conclusion that they could be manufactured at something like 3s. 9d. That fact had necessitated the dismissal of a very large number of supernumeraries, and great savings were effected. But there was one difficulty which they could not get over, the difficulty of durability. They could not succeed in manufacturing those lamps possessing a life time of half of those which were made by the American Company. He therefore thought it was best to cease their manufacture, a proceeding which entailed a large loss, and to throw themselves on the American Company. The new lamps were very good, and, he thought, compared favourably with any in the market. There had been some very tall talk on the part of the chairman of another company in connection with the incandescent lamp. He maintained now, as he had before, that the action of the Edison and Swan Company in securing what they seemed to regard as an entire monopoly of incandescent lamps was essential in the interests of the Maxim-Weston Company. As far as their Company was concerned they had been involved in no litigation with the Edison and Swan Company, and as to the question of litigation generally, it was not one that greatly concerned them, for they had the guarantee of the American Company that in the event of any litigation they would hand over to the Maxim-Weston Company a large sum of money, so that the litigation, if it ensued, which he hoped would not be the case, would be virtually by the Edison and Swan Company against the United States Electric Company. With respect to the contention of Mr. Forbes, he might say that the Maxim patent was attacked by the Edison people, but it succeeded, and that the Weston patent, which was attacked by the Cheesborough patent, also succeeded. As far as he could see, therefore, they had perfectly sound patents, which were unimpeachable, or, if impeached, could be upheld. As long as the Edison and Swan Company did not prepare to attack this Company they had no intention to attack the Edison and Swan Company. During the past year they had, in the shape of sending out estimates and general work, done a great deal more than during the previous year; but for the reasons he had stated, they had not succeeded in obtaining as many orders. Whenever the Company had made a reduction of 5 per cent. their competitors had made one of 10 per cent., and in many cases sustained a manifest loss on the contracts. He then went at considerable length into the principal items of the balance-sheet. He had, he said, already explained the item for patents. The auditor, very fairly, he thought, suggested for 1886 that the item, expenditure for wages, salaries and improvements should be detailed, and that had been done week by week. He did not see that they could do anything more than they had done. If the sum was to be placed to the debit of working expenses, it would, in his (the chairman's) view, be inequitable; and in the second place, it would postpone the payment of dividends. He did not think the shareholders wanted dividends postponed, and as long as they could equitably transfer the cost of working an amount which had been expended in relation to improvements account, he thought they were entitled to do so. It was of no use to talk of attempting to carry on an electric light company without making improvements. If they decided on such a course, he, for one, would not continue the management of the Company. If they were to stand still, and simply sell what they had got, without adopting improved dynamos and improved manufacture generally, they would not succeed. Other companies had spent ten times the amount which had been spent by the Maxim-Weston Company. With reference to the stock, a considerable portion of that had been made in the first instance owing to his desire to obtain a large share of Admiralty work. What was necessary was that they should reduce the speed of their machine by 50 per cent. If they had undertaken that work then it would have cost them £5,000. After long correspondence the American Company undertook to manufacture a machine in terms of the requirements of the Admiralty contract. They got five of those machines, because the American Company would not make less, but when the machines arrived here they were condemned by the Admiralty, and the Company were left with them on their hands. Up till some time in 1886 the Company were almost entirely dependent for their dynamos upon America, but now, he was happy to say, they were almost entirely independent; and, in fact, he considered they were in a better position than the American Company to turn out a plant equal in candle-power to the American product at less cost, owing, of course, to the protective system which America adopted. With respect to the item of shares in the Electric Sun Company, he understood that there was a prospect of that company being reconstructed, as some improvements had been made in the old Sun lamp, and he was led to believe that the

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item in the balance sheet of £239 would be more likely to turn out at £2,000. With regard to the item, orders, of £15,000, a considerable portion of that was for Government orders, and he hoped to receive in respect of them a very large cheque soon. As far as he could prognosticate the future, he felt satisfied that the reserve which they had made of £1,555 would amply cover any shortcomings which might come about in the realisation of that amount. In regard to the capital issued, it was a source of regret to him that the shareholders had applied only for a trifling amount of the last issue. The new money, in view of the improvements which they were making, would have been of great assistance to the Company. The Directors, however, had done their duty in the matter, and had subscribed in the proportion of ten times the sum found by the shareholders. The item of creditors and bills payable figured at £2,248 on the 31st December, but since then about £2,000 had been paid, so that the liabilities of the Company were of the most trifling character. With reference to the Watt patents, they were so designated out of courtesy to himself, and it was hardly necessary for him to say that others were interested in those patents, and some of the gentlemen he had had to buy out. The total sum he had spent in connection with those patents was from £2,000 to £3,000. They were originally offered to him, and as long as he was an official of the Company he would consider it his duty to give the Company the first offer of those patents, and as long as he remained with the Company they could manufacture them with no royalty. If the shareholders expressed a wish that the Maxim-Weston patents should be continued, the Directors would be speedily out of court in attempting to sell them against the existing competition. He did not think that in a public meeting like that it would be to the interests of the Company to state specially the relative cost of manufacture as between the Weston and Watt patents. The Company had not been involved in any expenses connected with the Watt patents beyond their having obtained the right of manufacturing with a view to meet the requirements of the trade. At present they were engaged in the manufacture of two machines on entirely different lines. He had already referred to the requirements of the Admiralty. The working plans, which were drafted for him by an outsider, were being carried out, and they had been approved by certainly one of the most eminent Government electricians. He had every reason to believe, therefore, that they would secure for those patents an enormous sale at an early day. The expense of manufacturing the new dynamos was 50 per cent. less than that of the Weston, and looking at the present prices which the Government were paying, they would be able to compete at an immense saving as compared with what they could do under the Weston system. They were enabled by the new lamp to subdivide the arc light from 15,000 to 150 candle-power. He thought, therefore, they would be able to supersede to a very large extent incandescent lighting. Shortly after he had been appointed a Director of the Company the conclusion he arrived at was that they must minimise the weight of metal for the maximum of results, and, in relation to the incandescent electric light, that they must secure an indestructible filament. They were working on those lines. If they succeeded the Company would have every advantage in the matter of any discovery he or any of his friends might make. They had succeeded in the matter of the arc lamp, and if they succeeded in regard to the incandescent light then they would be well in the van of electric lighting enterprise. The Company could have the Watt system if they thought fit, which was 50 per cent. cheaper than the Weston, and it would give them all the requirements of an electrical company, and they would thus have to spare the Maxim and Weston patents. Recently others had been moving in the matter of supply companies, and whatever other systems might be, including the Watt, there was no one superior to the Weston for a supply company. They had ample plant in stock to lay down stations. He had an idea as to the formation of supply companies, and, if possible, of the formation of a parent supply company, giving to them on terms advantageous to the Company the Maxim-Weston patents. If they did that they would obtain great advantages. Unless they were supported the Board could hardly expect to carry out negotiations and financial arrangements with that object, but they were willing to do their part. The Company was not a sensational but a manufacturing one. They could take no onus upon themselves as to the market value of the stock, and he should say, looking at the circumstances of the Company, that their stock was never more valuable than it was that day. Looking at the position of the Company and the intrinsic merits of its patents, he had no hesitation in saying that, notwithstanding the fact that they could not pay a dividend, they were in a better position than they were ever in before.

Mr. GEORGE HOWELL, M.P., seconded the motion.

Mr. L. SWABY said he desired to move an amendment appointing a committee of investigation. He stated that he had not himself seen the report until the shareholders generally had seen it, and that instead of having made £1,555 profit, they had made a loss. He maintained that the report was not the report of the Directors, that Mr. Brown's resignation had not been properly accepted, that Mr. George Howell was not a Director of the Company, that the balance-sheet was a farce, and that he (the speaker) was not in any way responsible for either the report or balance sheet. He then read a long correspondence with the view of bearing out these statements.

Mr. Under-Sheriff BEARD supported the amendment. He did not, he said, agree with the Chairman that the details of expenditure should not appear. Why, he asked, should not the shareholders know what had been done with their money, and why should they not know what it had cost to earn the £1,555 profit?

Mr. GREIG also supported the amendment, and thought that with the competition they had to meet they ought to have an influential Board, and that there should be more of the mercantile element in it.

Mr. J. M. KLENCK hoped that the meeting would not be led away by what Mr. Swaby said. They were a trading company, and a great deal would depend on their action that day. He himself thought that the £1,555 could not cover the amount of £15,000 for debtors. They ought to know the position of the Company as to the Watt patents.

A SHAREHOLDER called attention to the increased amount appearing under the head of patents, and wanted to know if the whole of that money had been spent in improving the Maxim patents, or whether any part of it had been spent in improving the Watt patent, in which the Company were not interested.

Mr. JACKSON cordially supported the amendment. He thought the Chairman had been too sanguine.

A SHAREHOLDER, in supporting the amendment, thought the name of Mr. G. Howell should be submitted to the shareholders for election.

The CHAIRMAN, in reply, said that when the Company was reconstructed Mr. Swaby subscribed for 4,000 shares, but he believed that that gentleman was more than a year in paying for them. The Directors felt from time to time that it was not fair of them to meet a Director sitting on the Board who was in default of his payments. Time after time he himself advanced Mr. Swaby money, and ultimately took the balance of the shares off Mr. Swaby's hands, as the latter had given to the Company bills which he could not meet. Mr. Swaby resigned on a former occasion because he could not pay his calls. They could not forfeit the shares of a Director without some arrangement, and that was the reason why he (the speaker) had himself acquired 2,000 shares held by Mr. Swaby. He did not desire to do so, having himself such a large holding already, but he had done so in order to maintain the honour and reputation of the Board. Before, however, he took those shares Mr. Swaby had sold them.

Mr. SWABY emphatically denied that statement.

The CHAIRMAN said that Mr. Brown resigned his position because he was unwell, as was also his wife, who had since died. For the year 1887 £500 was paid for Directors' fees, but he (the Chairman) had not participated in the payment. The reason that Mr. Swaby was not allowed to have a report and balance-sheet in the office was this, that he had charged Mr. Swaby from time to time with divulging matters affecting the interests of the Company, and it was a fact also that Mr. Swaby's brother-in-law had effected a partnership with a man who had done more to damage the Company than any living individual.

Mr. SWABY wanted to know what he had to do with what his brother-in-law had done.

The CHAIRMAN said that the Maxim-Weston Company was what he himself had made it. From time to time he had to find money for the Company to go on with, and he had had many sleepless nights in connection with it. With regard to the Watt patents, they were not originally his inspiration. They were brought to him, and he had paid cash in connection with them in order that the Company might have the advantage of them. But those patents were at the Company's disposal at the lowest possible price. The previous reserve account was absorbed up to 1886. It was specially stated that it was against bad debts, depreciation, &c. The Board were most willing at all times not only to have a committee, but they were anxious to have the assistance of every individual shareholder. He had always courted inquiry by the shareholders, and he could be seen at the office of the Company any day between 10 and 4 o'clock. He would have no objection to a friendly committee consisting of three or four gentlemen, if they liked to adjourn the meeting. He had intended to defray the cost of Mr. Howell's services out of his own pocket. (A VOICE: That won't do.) He saw no reason why the accounts should not be passed as presented, for the Committee could only deal with matters affecting the future.

Mr. JOHN NEWTON said that he had intended to support the amendment; but after the Chairman's statement it was impossible for him to do so. He, himself, had not doubted the existence of a reserve, but it was called by another name—balance of profit and loss account—and it would now be transferred to the reserve. He wished to support the Chairman in charging to capital all the money they spent in developments and improvements. If they did not do that they would have to reduce their 5s. shares to 2s. 6d.

Mr. HOWELL said, with regard to his election, that Mr. Watt had told him that he was in some difficulty in getting on with the work of the Board, and asked him (the speaker) to consent to act until the general meeting, which was held almost immediately—as it was held that day.

After some further discussion, the motion for the adoption of the report and accounts was agreed to with six dissentients, it being decided not to dispose of the remainder of the business on that occasion.

The following resolution was then submitted to the meeting, being drafted by the solicitor to the Company:—

"*That a committee of five be appointed to confer with the Directors as to the affairs of the Company, three to form a quorum, and that they do report to an adjourned meeting to be held this day four weeks, on the 25th April, 1888, at the same time and place.*"

The resolution was carried, and subsequently Mr. J. Newton, Mr. J. M. Klenck, Mr. G. H. Hildyard, Mr. John Marks, and Mr. Henry Alfred Greig, were elected the committee.

The CHAIRMAN, in reply to a question, said that he took it that the committee was formed to go into the affairs of the Company. He did not see what it would have to do with the private affairs of any one. Of course, anything in relation to his, or Mr. Swaby's affairs having an influence upon, or reference to the Company, must be considered, but nothing outside that.

On the motion of Mr. JACKSON, seconded by Mr. KLENCK, a vote of thanks was passed to the Chairman, and the meeting separated.

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THE INFLUENCE OF LIGHT UPON THE ELECTROSTATIC CHARGES.

The phenomena recently discovered by M. Hertz, with regard to the action of the rays of higher refrangibility upon the static discharge (see *Electrician*, February 3rd, p. 324) has led M. Hallwachs to try if an analogous effect would be produced upon a charged body. A well-insulated disc of zinc was connected to a gold-leaf electrometer, and a negative charge was communicated to it. In front of the disc was placed a metallic screen, having a window of glass, through which a beam of light from an arc lamp was thrown. As soon as the light falls upon the charged body it is found that the gold leaves rapidly fall together, and at the end of about 10 seconds the disc has entirely lost its charge. If the disc is charged with positive electricity the loss of charge proceeds at a very much slower rate, and the author remarks that in this case it is probable that the effect is due to some other cause. The rapidity of the discharge is independent of the thickness of the glass plate, but it is diminished when we replace this by a plate of quartz, rock salt, or felspar. If the screen is made of cardboard or of paper the phenomenon is not observed at all. On analysing the beam it is found, as might have been anticipated, that the violet and ultra-violet rays are chiefly concerned, whilst the ultra-red rays produce no effect whatever. These results are quite concordant with those of MM. Hertz, Wiedemann and Ebert. The nature of the charged body has a considerable influence; for iron the dissipation of charge is much slower than for zinc, and for aluminium it is slowest of all. A difference is also observed when the surface of the metal is polished. This leads to the supposition that a modification of the surface is produced by the ultra-violet rays.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 17th*, 1888.

New York has long maintained a sceptical frame of mind as to reports reaching it of blizzards in the West; but its extraordinary experiences on Monday last have brought it into a condition of humble belief. The rain storm beginning on Sunday night changed suddenly into a raging snow storm, the snow being peculiarly hard and fine, and by daybreak on Monday the streets were already covered with a foot or two. As morning advanced the condition of affairs became worse. The snow, flung at New York by a wind whose velocity reached fifty miles an hour, soon filled up the streets and stopped every single street railway. This would not have been so serious had the elevated roads remained active, but by noon, owing to snow blockades, breakdowns, and collisions, the traffic on these roads was also stopped. Thousands of people were kept waiting for hours in the air in the cold trains between stations, and at last had to reach the level of the street by walking the slippery track or by climbing down ladders. The state of the city grew worse from minute to minute, vehicles of all kinds were abandoned in the streets, and it was not until the afternoon that any sort of relief came, when, during a little lull in the storm, a few trains moved along the elevated road again. Hundreds and hundreds of merchants and clerks who reached their offices down town were compelled to stay there all night, and many of the large stores—some of which, by strange irony, were celebrating that day their "spring opening"—were compelled to accommodate for the night those of their *employés* who had managed to reach their doors. All outside communication with the outer world was cut off, as the overhead telegraph and telephone wires broke in every direction. Scores of trains were waiting three or four days to get into or leave the railroad depots in and around New York, and none of the passengers were able to communicate with their friends. On Monday night, owing to the number of breaks and crosses, it was deemed prudent not to run the regular electric light service, and as the gas was also out in a great many places, the terribly dismal appearance of things can be imagined. All this week the wires of all the various electric services have been in a state of chaos, the telegraph and telephone being the last to get back into anything approaching their former shape. Not only the wires but the poles went, and the wreckage is more complete in this city and for miles around than it has been any time since the great storm of 1876. It is but natural that this event, with its practically total stoppage of traffic and communication, should provoke some very strong talk as to the desirability of underground wires and an underground railway. That a great many more wires will be put underground as the result of this experience cannot be doubted, but it is to be feared that we may have yet to wait a little time before we get the underground road in place of, or even as an addition to, the unseemly elevated structures. When the underground road does, however, become an accomplished fact, I believe that it will be operated by electricity. It deserves note, while on this topic, that our first news from Boston came in *via* England. We are still without through telegraph wires to Boston—only about 200 miles—but the splendid long-distance telephone lines are in use.

The public generally are awaiting with a good deal of interest the production of Mr. Edison's improved phonograph, which has been promised for some time past, and is now said to be ready for the market. A few changes have been made in the machine, but to all intents and purposes it is practically the same as when Mr. Edison created such a tremendous and world-wide sensation with it in 1876. Despite the distraction of his thoughts and efforts to the electric light and other matters, Mr. Edison has from time to time harked back to this invention, towards which he has a feeling almost affectionate, and upon which he bases some very sanguine expectations. Before long, the little wax cylinders which Mr. Edison now uses in place of the old tin-foil will probably be familiar objects, and there are many speculations as to the extent to which the phonograph will invade business life and become the rival of the typewriter and the skilled stenographer. For my own part, knowing what I do of the phonograph, I do not ever expect to see it supplant the human stenographer in the higher ranges of verbatim reporting, but I do think that in many departments, where the work is slow and of a routine character, the phonograph will find its place, and a large one. Of this, however, you will be able to judge for yourself when you see the latest instruments. I hear that one of them is to be shown soon at the Electric Club here by Mr. E. T. Gilliland, and that the factory at Bloomfield has a capacity of about twenty-five complete instruments a day. Meantime, however, the Graphophone Company, based on the patents of Prof. Bell and Mr. Tainter, have not been idle. It is even said that there are to-day in New York 200 graphophones ready for sale. This looks like a conflict in the courts at no very distant date, as there is not much to distinguish between the two instruments. One interesting little application of the phonograph is that of its use in talking dolls. A company, in which Dr. Jaques, of the American Bell Telephone Company, is interested, has been organised in Boston, and is now experimenting with dolls which have phonographs in their little insides, and which, when the machines are set in motion, talk and sing.

Now that so great an interest is taken in the subject of currents of high E.M.F. and their danger, it will interest many of your readers to know that Mr. Wood, the electrician of the American Company, has just built a dynamo which produces a current of 6·8 amperes, at 4,100 volts, for lamps to give 1,200 candle-power. The use of currents of such high voltage necessarily involves very good line construction, and undoubtedly complicates the problem of putting the arc light wires underground.

I believe I have already informed you of the fact that the subject of execution by electricity is now being actively debated in Massachusetts, which in the matter of social reforms never likes to play second fiddle to New York. There, as here, great difference of opinion exists. It is interesting to note that at the meeting of the Society of Medical Jurisprudence, held here a few days ago, the late report of the State Commission

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was brought up for discussion, and after quite a lively and interesting debate a resolution was adopted almost unanimously against the Bill now before the State Legislature providing for execution by electricity. The doctors were not in any instance influenced by sentiment, or by the idea that electricity is degraded by being used as a means of punishment.

I find among telephone men the prevalence of the belief that the Supreme Court of the United States will hand down its decision in the telephone suits next Monday. The reason for this is that the Court then reassembles after a brief vacation, which is usually given to the writing of decisions. It is, of course, probable that the anxious public will once more be doomed to disappointment, but if a decision is rendered you will undoubtedly hear of it by cable before this letter reaches you. The parent telephone company in Boston is pursuing the even tenor of its way and a few more infringers.

While you abroad are discussing the transformer from the scientific point of view, the discussion on this side seems at present confined to the commercial aspect, and the first of a series of papers on the subject of continuous *versus* alternating current from this standpoint in particular was read this week before the Chicago Electric Club by Mr. H. Ward Leonard. Mr. Leonard's paper was entitled "The Comparative Value of the Continuous and Alternating Current Systems for the Commercial Distribution of Electricity," and he decided in favour of the continuous current. Mr. Leonard, in considering the value of the two systems, compared them with each other on the following points, namely, first cost, economy, efficiency, depreciation, reliability, variety and value of the possible sources of revenue, safety of life, and effects on existing property. Naturally, first cost and economy occupied the principal part of the paper. On the latter point Mr. Leonard showed that assuming the highest efficiency claimed for the alternating current generator, and assuming the generator efficiency as equal to that of a continuous-current generator under condition of partial load, and the converter efficiency to be the same at all loads, the three-wire system, with a maximum loss of 20 per cent. in the feeders, has as high an efficiency as the converter system, and in addition the three-wire system, as usually installed, with a maximum of 10 per cent. loss in conductors, has an efficiency of from 4 to 12 per cent. superior to that of the alternating-current converter system. Taking up next the question of first cost, Mr. Leonard has reduced everything to the cost per lamp for various lengths of feeders, and he has endeavoured to show that if the three-wire system be operated at an average efficiency of 92 per cent. in the feeder—which corresponds to the highest efficiency claimed for the alternating-current converter system—the total cost per lamp would be equal when the average length of feeder was 6,000ft.; and, according to Mr. Leonard, an average length of feeder of 6,000ft. corresponds to a circular area 18,000ft. in diameter, or about 3½ miles. With 94 per cent. efficiency in the feeders, the point at which the three-wire system is cheaper for lamps than the alternating-current system is 4,750ft.; and even with an efficiency of 96 per cent. in the feeder, or an average loss of 4 per cent., the conductors of the three-wire system are shown to be cheaper than the conductors and converters of the alternating-current system for an average length of feeder of 3,600ft. or less.

But Mr. Leonard held that if, as was more than probable, the voltage of the incandescent lamp would be doubled, and its economy increased 25 per cent., then, with the highest efficiency in the feeders—that is, 96 per cent.—the three-wire system would be the cheaper for cases where average distance of lamps is 8,000ft. or less. Treating also on the question of depreciation, Mr. Leonard maintained that the elements of depreciation in the converter system were far greater than in the direct current, and he cited as a comparison the value of copper conductors 20 years hence which cost $1,000 to-day, as against $1,000 worth of converters having small highly insulated wires. On the score of reliability, Mr. Leonard doubted the possibility of continuous operation of a system which thus far is still operating in single units, each dynamo feeding its individual circuit. Without the possibility of multiple arcing the machines at the station, Mr. Leonard holds that the system is open to serious drawbacks. Regarding the variety and value of the possible sources of revenue to be drawn from the two systems, the old arguments in favour of the continuous current are advanced, such as that the revenue from power distribution, from lamps and charge of storage batteries, &c., while obtainable with the continuous current, is impracticable with the alternating; and while the continuous current can be applied to all these, the alternating is necessarily limited thus far to the production of light, and possibly heat, only. The question of safety to life was also touched upon, and the dangerous character of the alternating and the harmlessness of the low-potential continuous current were dwelt upon. This paper will probably be followed by another in which the other side of the question will be taken up, and we may expect some interesting rejoinders.

TELEPHONE AND TELEGRAPH PROJECTS IN SCANDINAVIA.

(From our Stockholm Correspondent.)

There is no capital in Europe which can boast a more perfect telephonic arrangement than Stockholm, which also, if I am not mistaken, has the largest percentage of subscribers of any European town. Negotiations are at present pending for an amalgamation of the Stockholm General Telephone Company with the Telephone Company of Gothenburg, on the opposite side of Sweden. The Stockholm Telephone Company has offered to take over the one at Gothenburg, with buildings, wires, appliances, &c., and to substitute phosphor bronze wires instead of the steel wires now used, and telephones from L. M Ericson and Co., Stockholm, instead of those hitherto used, and to supply the station with multiple tables of best and newest construction, against each member obtaining one-third of a share in the General Telephone Company, Stockholm, the nominal value of each share being 300kr. The proposed terms for subscribers in Gothenburg under the new management are (per annum):—

A. For use of a telephone with own line to the central station.
   (*a*) If the subscriber is a member of the present company, and uses his old telephone, 70kr.
   (*b*) If one of L. M. Ericson's telephones is used, 80kr.

B. For use of a telephone in connection with double automatic exchange, 60kr.

The agreement should hold for five years, and commence on October 1st, 1888.

Should this proposal be accepted, there is every likelihood of the two towns before long being brought in telephonic connection, and that Gothenburg will also be connected with those towns that are already in connection with Stockholm. The new arrangement would no doubt also be made to comprise an additional number of towns in middle and South Sweden.

The Stockholm Telephone Company have applied to the Government for permission to fix telephone wires along the ordinary roads between Stockholm and Jönköping, Jönköping and Gothenburg, and Jönköping and Malmö, partly by direct lines and partly, between Stockholm and Gothenburg, by a line which should comprise Nyköping, Norrköping, Linköping, with branches to Motala and Örebro, Jönköping and Boros. The project also comprises a line Stockholm-Gefle-Söderhamn-Hudiksvall and Sundsvall. The Government is to have the right to purchase under certain conditions. It is the intention to make quite a new departure, as far as Sweden is concerned, in connection with these lines, as double wires of copper will be used. Hitherto, single lines have been used everywhere, with a single exception, and the wires have been of iron, which can only suffice within comparatively narrow limits.

In Norway there are also several new telephone lines on the *tapis*, one being through the Guldbrands valley, where the inhabitants complain that their only connection with the outer world is a post every three weeks.

The Christiania Telephone Company had at the close of last year 1,670 subscribers, and the number of telephones under the company's control amounted to 1,812. The average number of conversations on a week day was 7,000—9,000, and on a Sunday or other holiday 500—800.

The General Stockholm Telephone Company has purchased the Jönköping Telephone Exchange erected by the firm of Brunius and Co., and it has at once been taken by the Stockholm Company. The Jönköping Telephone Company is seven years old, and has 67 subscribers, which number is likely to be doubled on account of the favourable conditions offered by the Stockholm General Telephone Company.

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The proposed tax in Sweden of 10kr. on each telephone meets with a great deal of opposition from various parts of the country. and will in all probability not be carried.

The Swedish State Telegraphs have applied to the Government for their sanction of the charge for home telegrams being reduced to 50 öre (about 6½d.) for a message of ten words, and a charge of 5 öre for each additional word. In order to meet the anticipated decrease of profits—at least, in the first year—a grant of 100,000kr. has been asked for. The new charge is not intended to come into force till the beginning of next year.

CORRESPONDENCE.

ELECTRIC TRACTION: SERIES SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. W. Geipel gives an extract from the patent of Profs. Ayrton and Perry's of 1887. I have a copy of this, as well as of the same of 1883.

The words, "as we may employ a magnetic arrangement depending for its action not on the weight of the train, but on its magnetic mass," is not sufficient as description, even for a patent, and in what way Profs. Ayrton and Perry themselves at the time understood this Mr. Geipel may find in their 1883 patent, No. 2395, p. 19, to which I have before referred.

After my and Mr. Binswanger's invention it is possible to find in the above sentence quite another sense.

Further, the object of our invention is "*safety* conductors for *tramways*"—that is, to make possible the electric traction on town streets, to build tramway lines which do not interfere with the heaviest traffic, and not simply, as Mr. Geipel says, "evidently to overcome the difficulty of leakage in long lines." This, judging from their patents, Profs. Ayrton and Perry did not intend to make or succeed in making.

I have not yet read the lectures of Prof. Ayrton kindly mentioned by him in your paper of March 9th, and wishing to give always to others what is theirs, but to keep what is mine, I must know who is the owner of what. I hope Prof. Ayrton will be so kind as to send me a copy of his most exhaustive lectures, and thus help me to clear up the subject.

I will leave Mr. E. Bergholt, secretary to the Series Electrical Traction Syndicate (Limited), in his sweet dream as to the "points of contact," and advise, as a very interesting subject of investigation, the patents and proposals taken out and made before 1881. After careful study Mr. Bergholt will, I think, change his opinion, if it were only his private opinion.—Yours, &c., CHARLES POLLAK.

11, Rue Descartes, Paris, 21st March, 1888.

FIRE OFFICE RULES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We, in common with the author of the letter in your issue of 16th inst. on the above subject, feel exceedingly alarmed at the prospect that opens out before us now that another set of rules has been published. It would be difficult to arrange at the present stage of the industry any set of rules the following out of which could better guard against dangers arising from electric lighting than those which have been drawn up by Mr. Musgrave Heaphy. The writer has seen a number of installations both on the Continent and in the United States, with the result of feeling assured that work of this kind in England is infinitely superior to that carried out in other countries, and there can be no doubt that our comparative immunity from fire arises from the judicious enforcement of these regulations.

A number of installations in this kingdom, including one or two of the largest, have been carried out by us, always under the Phœnix Fire Office Rules, and in no single instance has an electrical fire occurred.

It must certainly be the experience of every contractor that there is no difficulty in obtaining the approbation of the authorities of installations conscientiously executed.

If we are to have several sets of rules, it will be impossible to tender for work without a specification, and this means an expensive item added to the price of electrical work for the services of a consulting electrical engineer in each case, whose presence is unnecessary when a duly qualified fire inspector fills the position, free of cost to the proposed user of the electric light.

We do think that this is a matter for the leading contracting firms to interest themselves in, and their verdict goes almost without saying.

To frame and impose rules, it is necessary to have a "status": what is the "status" of those who are seeking to introduce the new ones, and what authority have they to handle a matter which so seriously affects the trade without first consulting it?

The matter is such a serious one that we trust more *direct and public impeachment* will quickly ensue.—Yours, &c, "INSTALLERS."

London, March 22nd, 1888.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We are in the throes of a new Electric Lighting Act, and expect its passing to open up an era of prosperity for the electric industry in this country, when at the outset irresponsible parties throw the apple of discord amongst us.

Do these "new rule" concoctors pay for fire damages or the fire offices? And how do they suppose to overcome the refusal on the part of any fire office to take a risk? If an installation is put up in accordance with their rules, I take it that the fire offices are agreed as to the value of the Phœnix Rules, and are content to take risks if the work is carried out in accordance with them.

I have always found every disposition on the part of Mr. Heaphy to look at any necessary modification of these rules in a broad manner, provided good reasons for deviating without risk could be shown.

There ought to be no difficulty in settling this interference. Let each contractor ignore the existence of these new rules, and we shall soon hear no more of them.—Yours, &c,

E. A. PARIS.

Gothic Works, King-street, Norwich, March 23, 1888.

THE PERCENTAGE ACCURACY OF WATTMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In a review of "Le Wattmètre et son Maniement," which appeared in *The Electrician* of March 16th, there is an oversight in the calculation of the coefficient K which expresses the ratio of the reading on the wattmeter to the true watts in the circuit. There should be a factor, r, in the second term of the numerator, and a factor, r', in the second term of the denominator of the second expression given for K, and the omission of these vitiates the subsequent algebraical formulæ, though the results obtained are correct in their general characters. In particular, K instead of 1·5, comes out to be about 129 in the case considered, and the error, if reckoned as a percentage upon the true watts, is somewhat appalling.

It would perhaps hardly have been necessary to point out this correction if there were nothing more to be said, for a 50 per cent. error would be generally considered quite large enough to condemn an instrument, and I should merely appear to be slaying the slain; but it seems to me that a number obtained in this way is misleading to the last degree, and gives no clue whatever to the extent of accuracy which we may expect from the instrument when used as it always would be in practice.

Prof. Ayrton's formula is obtained on the assumption that all the power which we want to measure is spent in the heating of the circuit due to its resistance—that is, that there is no loss due to Foucault currents, or to hysteresis, or, which is most important of all, to the effect of mutual induction between the circuit and any other, and it is only applicable when these conditions hold. For example, when measuring the power given to a transformer, it can only be an approximation to the truth when the secondary is open. In this case, however, the power given to the primary will be only a very small fraction of its normal amount, which, I take it, is what a wattmeter is in practice designed to measure, and

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an error which is unimportant compared with the latter may at first sight seem formidable when expressed as a percentage of the power.

In the same way if a wattmeter be used to measure the power given to a lamp circuit in which the lamps may be replaced by impedance coils, it may be quite possible that when all the lamps are out the indicated watts may differ from the true watts by a quantity large compared with the latter, and yet negligible compared with the watts when the normal number of lamps are alight.

I do not for one moment wish to be understood as defending the relation between self-induction and resistance given by Messrs. Ganz; indeed, I think ·02 ohm seconds an enormous self-induction for a resistance of only 250 ohms, and one which could not fail to introduce in practice errors which would be far from unimportant; but what I desire to point out is that a true criterion of what may be expected from a wattmeter is not in general furnished by Prof. Ayrton's formula, and can only be obtained when the uses to which it is intended to put the instrument are specified.

I have had occasion to devote a good deal of time to this subject, and the conclusion to which I have come is that it is quite impossible to design any wattmeter depending upon electromagnetic attraction which will measure with good percentage accuracy the power in a circuit when the difference between the phases of current and E.M.F. is nearly 90°, but that in all other cases the construction of suitable instruments presents no other difficulties than those of mechanical detail. The accurate determination of activities, which are small, while both the current and E.M.F. are large, is, however, only needed in research and testing work, where the other well-known methods of measuring power are applicable; and with this the wattmeter as a commercial instrument is not required, fortunately for itself, to have anything to do.—Yours, &c.,

March 28, 1888. L. R. WILBERFORCE.

PRODUCING OXYGEN GAS BY ELECTROLYSIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly say what is the lowest cost oxygen can be produced by electrical decomposition of water, stating means used; also, would an ordinary low-tension dynamo produce 1,000 cubic feet per day, or what plant would be required? Your kindness will oblige.—Yours, &c., B. W. SMITH.

Smethwick, 21st March, 1888.

[In reply to our correspondent's inquiry, we may say at once that the electrolytic production of oxygen cannot compete as a commercial process with other well-known methods. Brins' process, or even the ordinary oxide of manganese and chlorate of potash process, will be found less costly. The following calculation of the expenditure of energy required to produce 1,000 cubic feet of oxygen by electrolysis of water will probably, however, enable our correspondent to form his own opinion as to the value of the process:—

1,000 cubic feet = 28,420 litres.

1 litre of oxygen at standard pressure and temperature weighs 1·4298 gramme.

1,000 cubic feet of oxygen therefore weighs about 40,600 grammes.

The electro-chemical equivalent of oxygen is ·000084; that is to say, a current of one ampere will in one second liberate a weight of oxygen equal to ·000084 gramme.

The liberation of 1,000 cubic feet of oxygen will therefore require $\frac{40{,}600}{\cdot 000084} = 483{,}333{,}000$ coulombs, or 134,250 ampere-hours. Now, including losses in leads, &c., it will be safe to take 3 volts as the E.M.F. required per cell. Hence the expenditure of energy is given by

$$\frac{3 \times 134250}{746} = 540 \text{ horse-power-hours, electrical.}$$

Assuming a day of twelve hours, this represents the output of a dynamo machine of 45 electrical horse-power, which is equivalent, say, to 65 indicated horse-power from the engine. Our correspondent can easily make his own calculation as to the cost of energy from this point from his local knowledge; but if we assume the value of an indicated horse-power-hour as 1½d. we should have £4. 17s. 6d. per 1,000 cubic feet. This figure, it must be remembered, only takes account of the actual cost of energy consumed; we shall be happy to give our correspondent any further assistance in our power.—ED. *E.*]

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

4,119. H. C. B. SHALDERS and A. J. THORMAN. London. Electrical appliances for curative and strengthening purposes. March 17, 1888.

4,153. F. KING. London. Improvements in means for regulating or controlling the secondary current derived from continuous electric current transformers. March 17, 1888.

4,171. W. S. FREEMAN. London. Electrical governor for motive-power engines. March 17, 1888.

4,177. E. BAINES. Halifax. Improvements connected with insulators for the purpose of regulating the tension of telegraph and telephone line wires. March 19, 1888.

4,188. F. J. BEAUMONT and J. KENT. London. An improvement connected with arc lamps, whereby the controlling mechanism is contained in a box four inches deep or thereabouts. March 16, 1888.

4,208. C. W. F. THODE. London. Improvements in apparatus for opening doors by pneumatic or electrical agency. March 19, 1888.

4,221. T. COAD. Forest Gate. Improvements in the construction of holders for incandescent lamps. March 19, 1888.

4,222. H. P. HOLT. London. A regulating appliance for dynamo-electric machines worked by gas motor or other engines. March 19, 1888.

4,240. H. B. YARDLEY. Charlton. Improved apparatus for the making and breaking of contact in electrical appliances, especially applicable for burglar alarms and instead of pushes for ringing electric bells. March 20, 1888.

4,270. B. A. FISKE. London. Improvements in the method of and apparatus for controlling or regulating the movement of electro-dynamic motors, or of machinery or apparatus propelled or driven thereby. March 20, 1888.

4,274. W. P. THOMPSON. Liverpool. Improvements in or relating to storage batteries (C. D. P. Gibson, United States). March 20, 1888.

4,275. W. P. THOMPSON. Liverpool. Improvements in or relating to storage batteries (C. D. P. Gibson, United States). March 20, 1888.

4,277. A. J. BOULT. Liverpool. Improvements in electro-mechanical movements (J. F. McLaughlin, United States). March 20, 1888.

4,292. C. E. G. GILBERT. London. An improved switch and fuse for electric light and other purposes. March 20, 1888.

4,294. A. MYALL. London. A harmonic commutator for alternating currents (W. Judd, Hong Kong). March 20, 1888.

4,317. J. J. MASON. Lincoln. An electric lamp and bell, and improvements in electric lamps. March 21, 1888.

4,330. P. FUESS. London. An improvement in dynamo-meters. March 21, 1888.

4,345. G. KAPP. Manchester. Improvements in the method of and apparatus for distributing electrical energy by alternating currents from central stations. March 21, 1888.

4,353. E. W. BULLER. London. Improvements in electric telegraph insulators and in the manufacture thereof. March 21, 1888.

4,393. W. S. FREEMAN. London. Improvements in and relating to the control of electric currents. March 22, 1888.

4,425. P. J. CHARLES, L. HANSON, and R. H. FOWLER. London. Improvements in dynamo-electric machines or motors. March 22, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

March 24, 1888.

4,116. A. F. ST. GEORGE and C. RUS BONNE. Improvements in electric incandescent lamps, and in the method of manufacturing the same. March 18, 1887.

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5,862. W. BLENHEIM. Egham. Simultaneous driving of a number of clocks by magneto-electricity. April 22, 1887.

5,958. A. M. CLARK. London. Improvements in dynamo-electric and magneto-electric machines (L. Maiche, France). April 23, 1887.

6,754. R. E. B. CROMPTON and J. SWINBURNE. Chelmsford. Improvements in and connected with dynamo-electric machines. May 9, 1887.

6,917. W. M. MORDEY and C. E. WEBBER. London. Improvements in electric transformers, induction coils, or inductional resistance coils. May 11, 1887.

6,987. A. SIEMENS. London. Improvements in electric arc lamps. May 12, 1887.

7,021. G. SCARLETT. Liverpool. Improvements in electro-dynamic and dynamo-electric machines. May 13, 1887.

15,056. J. A. BETTS. London. An improved multiple electric cable. November 4, 1887.

112. H. F. JOEL. London. Improvements in incandescence lampholders and switches. January 4, 1888.

506. C. M. DORMAN and R. A. SMITH. Improvements in the construction of suspension fittings for incandescent electric lamps. January 12, 1888.

750. H. H. LAKE. London. Improvements in and relating to electric railways and to vehicles for use thereon. (D. G. Weems, United States). January 17, 1888.

PATENTS SEALED.

March 23, 1888.

1,904. G. KAPP, W. H. SNELL, and J. M. V. KENT. London. Improvements in the construction of transformers. February 7, 1887.

2,130. F. JEHL. Paris. Improvements in electrical inductors and commutators therefor. February 10, 1887.

2,134. A. SCHANSCHIEFF. Gipsy Hill. Improvements in miners' safety lamps and in galvanic batteries especially suitable therefor. February 10, 1887.

3,560. E. C. WARBURTON. Manchester. Improvements in holders and fittings for electric lamps. March 9, 1887.

3,611. P. G. FORBES. London. Improvements in laying electrical conductors underground. March 9, 1887.

3,782. E. EDWARDS. London. Improvements in electric telegraphs (D. Kunhardt, Germany). March 12, 1887.

3,785. E. W. BECKINGSALE. London. Improvements in junction and testing boxes for electrical conductors. March 12, 1887.

3,917. C. WITTENBERG. United States. Improvements in registering apparatus for use in connection with telephones. March 15, 1887.

9,725. W. P. THOMPSON. Liverpool. Improvements in dynamo-electric machines (G. Westinghouse, jun., United States). July 12, 1887.

14,260. S. C. DREW. United States. Means for preventing induction in telephonic circuits. October 20, 1887.

15,588. J. Y. JOHNSON. London. Improvements in dynamo-electric machines (W. C. Rechniewski, France). November 14, 1887.

16,558. A. WRIGHT. Brighton. Improvements in apparatus for measuring and regulating electric currents. December 2, 1887.

SPECIFICATIONS PUBLISHED DURING THE MONTH.

4,225, 1887.—G. HOOKHAM. Electricity meters. (Price 1s. 1d.)

5,709, 1887.—A. J. GRAVIER. Dynamo-electric machines. (Price 8d.)

5,867, 1887.—W. KINGSLAND. Secondary batteries. (Price 8d.)

6,294, 1887.—A. WATT. Electrolytic treatment of zinc, &c. (Price 6d.)

COMPANIES' MEETINGS & REPORTS.

The Direct Spanish Telegraph Company (Limited).

The twenty-ninth ordinary general meeting was held at Winchester House, Old Broad-street, last Monday, under the presidency of Sir James Anderson.

The MANAGER (Mr. C. Gerhardi) read the notice calling the meeting, and the minutes of the last meeting, which were approved and signed by the Chairman as correct.

The CHAIRMAN: Gentleman—I suppose we will take the report as read (hear, hear). On reading it over carefully myself again, I must say that I find very little to add to it. It is a very neat report, very short, and yet it conveys everything that I can think of worth saying. You will notice in the second paragraph that our traffic has increased by £1,338, notwithstanding the fact that on the Barcelona section the traffic has fallen off, owing to the absence of speculation. The increased traffic we have obtained is therefore due to other parts of Spain. I may further add that in the first three months of the present year there is a further improvement in the traffic of about £250—that is taking into account the estimated revenue for the Easter week, which is always a small one. I hope, therefore, that for the present year we shall get up to 5 per cent. dividend on the ordinary shares. It only requires £600 to pay us 1 per cent., and I do not see why we should not get to that amount of dividend by-and-bye—I hope more, because the trade of Spain is evidently taking a start. It required no less than 181,000 additional words to make up that increase in our traffic of £1,338 in the last half year. What, however, pleases me more than anything else is the last paragraph in the report, where you find that over £8,000 stands to the credit of the reserve fund. Of that amount £5,000 is invested in Forth Bridge Railway Four per Cent. Debenture Stock, and Liverpool Corporation 3½ per Cent. Stock, and the value of that investment has increased by £250 since we bought it. I hope next time we meet we shall be able to show in our accounts our investments on account of reserve, as is customary in other companies. I told you at the last meeting, I think, that we were getting a direct wire from Madrid to Bilbao. It is not quite finished, but I hope when we get it the traffic will still further improve, because nothing more increases telegraphic communication than the rapidity and accuracy of transmission. Our average time now from Bilbao to London is only five minutes, leaving, I think, nothing to be desired; but if we can get a special wire to Madrid, we may get through messages in five or seven minutes to Madrid; then I think we should have a further improvement in our traffic. I do not think there is anything more to tell you unless you ask questions. The Company is prosperous. We are working at a very low tariff, as I stated at our last meeting, and yet we are increasing our revenue. Last time I had to tell you that the traffic had fallen off for the previous three months. Now I have to tell you that it is increasing, and but for the Easter week, which Mr. Gerhardi has estimated in the three months' revenue, we should have had ½ per cent. more dividend already earned, a fact which, to my mind, is altogether satisfactory. We should get a little more reserve, and pay away the revenue to the hilt, and the Direct Spanish will then compare with any telegraph company in London. With these remarks I beg to move

"*That the report and accounts now presented be, and they are, hereby received and adopted.*"

Mr. ETLINGER: I beg to second that.

Mr. DYETT asked for an explanation of the item in Abstract 3, "Stationery, including Morse bands, &c."

The CHAIRMAN, in reply, said the Morse bands were the tapes on which the signals from the instruments are recorded. They used an immense number of these bands. And with regard to the stationery, that naturally increased with the growth of the traffic.

Mr. DYETT then referred to the item of unclaimed dividends, and asked whether the Secretary did all he could to reduce that amount, and get the money paid to those to whom it belonged.

Mr. JOHN NEWTON asked whether it was necessary to put £5,000 to the reserve fund.

The CHAIRMAN: Yes, that is a settled matter, and I would resign rather than that it should be interfered with.

Mr. NEWTON thought it was quite right if it was understood, and it made the Company stronger. Still, the amount was large compared with the reserve fund held by other companies.

The CHAIRMAN: It was part of the agreement. We put it before the Court.

Mr. NEWTON said that it of course made the Company stronger. The time would come when they would have such a strong reserve that they would have to issue bonus shares.

The CHAIRMAN: You must remember that our debentures are terminable.

Mr. NEWTON thought it very satisfactory to see a large fund accumulating. For his own part he would not be sorry to see the item of unclaimed dividends increase still further. If the persons to whom the sums belonged had left the country or were dead, and their executors did not care to claim the amount, the Company must have the benefit of it. He thought it was a mistake to put the item in the report at all. It was as much an outstanding liability to creditors as any item they had in the balance-sheet, and it should appear as that.

Mr. DYETT said he did not agree with Mr. Newton as to the unclaimed dividends. The money did not belong to the Company, and any neglect in paying it over to the parties to whom it belonged ought to be avoided.

The CHAIRMAN: But we have great difficulty sometimes in finding out to whom the money belongs. We do all we can to give notice that we have these dividends in our possession.

He then put the motion, and it was carried unanimously.

The CHAIRMAN next proposed

"*That a dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend of 2¼ per cent. for the half-year on the ordinary shares, free of income tax, be and are hereby declared.*"

Mr. ETLINGER seconded the motion, which was carried unanimously.

On the motion of Mr. ETLINGER, seconded by Mr. J. D. PENDER, Sir James Anderson was unanimously re-elected a Director.

Sir JAMES ANDERSON proposed, and Mr. J. DENISON PENDER seconded, the re-election of Mr. Etlinger as a Director, which was carried unanimously.

Mr. BARNETT then proposed the re-election as auditor of Mr. Herbert R. Duke, remarking that the remuneration of that gentleman was very

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small, being only ten guineas. He thought the Board might consider whether the amount could not be increased.

Mr. ETLINGER said it was entirely a shareholders' question.

The resolution was then carried, it being agreed to raise the amount to fifteen guineas.

Mr. NEWTON proposed a vote of thanks to the Chairman, by whose efforts, he said, the Company had been brought to a living condition, a fact which the Chairman and his colleagues might be congratulated upon.

Mr. C. BURT seconded the motion, which was carried *nem. con.*

The CHAIRMAN: In the name of my colleagues and myself I thank you. As to one remark of Mr. Newton about the large reserve—we make our debentures terminable, and when that happy time comes, we may use some of the reserve, and if I had my own way, I would call up the remaining £1 per share. That, however, is a long way off; but we may as well pay ourselves 6 per cent. as the debenture holders.

Mr. NEWTON inquired when the debentures terminated.

The CHAIRMAN: In May, 1894. In further reply to Mr. Newton and Mr. Dyett, he stated that they could not pay off the debentures before that date without giving a premium. They could only pay them off by agreement. Until they had a much larger reserve the matter did not seem to press.

Mr. DYETT suggested that the £1 a share should be called up.

The CHAIRMAN: Well, that would be £13,000, and if you had £7,000 of reserve to add to it, it would go some way towards covering the amount required.

The proceedings then terminated.

China and Japan Telephone Company (Limited).

The following is the report of the Directors of this Company for the year ended the 31st December last, presented at the fifth ordinary general meeting of the Company, held at the registered office of the Company, 14, Austin Friars, in the City of London, E.C., on Monday last:—

The revenue account, after having been charged with debenture interest, and a sum of £122. 13s. 7d. having been written off in respect of depreciation, together with a sum of £108. 10s. 8d. in reduction of preliminary expenses, shows a balance of £642. 10s. 3d. at credit.

This amount has been carried to profit and loss, and finally wipes out the balance of £419. 6s. 7d. still standing at debit of that account, and leaves a surplus of £223. 3s. 8d. to be carried forward, which the Directors regard as eminently satisfactory.

The exchange at Hong Kong was re-opened in January of last year, and now numbers some fifty subscribers. It is hoped that with a good and continuous day and night service, which is now being given, the public will be more ready to lend its support to the Company, and that the present year may see further additions to the number of subscribers

The subscribers to the Shanghai Exchange have again reached the numbers at which they stood before the advance in the rate of subscription was made, as alluded to in last year's report, and an encouraging feature of the year has been the acquisition of several Chinese firms to the exchanges.

Considerable progress in the extension of both the telegraph and telephone systems appears to be taking place throughout China, and when the Chinese begin to thoroughly understand and appreciate the advantages of the telephone, both from a business and social point of view, the Directors look for an extension of the Company's exchanges, both at Shanghai and Hong Kong.

A good demand has existed for telephonic instruments and electrical material from outports, and fair profits have been realised from sales. Owing, however, to competition from various quarters, these have latterly been much reduced.

The Director who retires at the present meeting is Mr. Thomas Lloyd, but being eligible he offers himself for re-election.

Messrs. Price, Waterhouse and Co., the auditors, also retire, and offer themselves for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended March 23rd amounted to £5,094.

GLOBE TELEGRAPH COMPANY.—The directors of this company have declared the payment of an interim dividend on the preference shares of 3s., less income-tax, and of 2s. on the ordinary shares, the income-tax having already been deducted, payable on the 18th proximo, for the quarter ending April 18th, 1888.

THE SCHANSCHIEFF BATTERY COMPANY.—The prospectus is issued of the Schanschieff Electric Light and Power Company, with a capital of £200,000 in 40,000 £5 shares, of which the present is a first issue of 30,000 shares, of which 20,000 are offered to the public, the remaining 10,000 being taken by the vendor, together with £70,000 in cash or shares, at the directors' option, and half the amount arising from the sale of, or licenses to use, the patents in any countries except the United Kingdom, in payment for the patent rights. This company is formed to purchase from the Schanschieff Electric Battery Syndicate the patent rights for the United Kingdom, France, Belgium, Germany, Italy, United States of America, and India for the Schanschieff single-liquid battery, and also the benefit of applications for patents in respect of the invention, which have already been made by the vendors in many other countries, together with the right to patent the invention in all other countries in the world in which patents or similar rights can be obtained.—It is stated that the capital of the company has been over-subscribed.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended March 23rd, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,179.

NEW COMPANY REGISTERED.

THE JULIEN ELECTRIC COMPANY (LIMITED).—Registered by Walter Webb and Co., 23, Queen Victoria-street, London, E.C. Capital £100,000, divided into 10,000 shares of £10 each. Object, to purchase or otherwise acquire the British patents, viz., 1885, No. 8,881, improvements in secondary batteries, part of which is applicable to primary batteries; 1886, No. 2,470, for improvements in electrical locomotion, propulsion or traction, and the apparatus therefor; and also the benefit of an application for Letters Patent 1887, No. 8,855, for improvements in and appertaining to electric piles and plates therefor, and for such purpose to enter into and carry into effect the agreement referred to in the Article of Association, either in its present form or with or subject to such modifications as may be agreed upon, or to purchase or acquire the said patents, or any of them, or any interest therein upon other terms; to carry on the business of manufacturing or dealing in engines, machinery apparatus, rolling-stock, or other things which are manufactured or used in accordance with the said inventions. The first subscribers are:—

	Shares
A. W. Ripping, clerk, 9, Woodville-road, Mildmay-road, Islington, N.	1
R. R. P. Braithwaite, clerk, 56, Osnaburgh-street, Regent's-park, N.W.	1
A. F. Stokes, stationer, 5, Birchin-lane, E.C.	1
T. B. Weare, oil merchant, 50, Devonshire Chambers, Bishopsgate-street	1
A. Barton, clerk, 30, Malvern-road, Dalston, E.	1
R. Gordon, gentleman, Acacia grove, New Maldon, Surrey	1
A. G. Pavill, clerk, 2, Cavendish-terrace, Frant-road, Thornton Heath	1

The number of directors shall not be less than three nor more than nine, in addition to any managing director or directors. The first directors shall be appointed in writing by the subscribers to the Memorandum of Association. The qualification of a director shall be the holding of stock, shares or debentures of the company of the nominal amount of £200. The remuneration of the directors (other than the managing director) shall be a sum equal to £100 per annum for each director, with an additional £100 per annum for the chairman.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Tuesday, Mar. 27, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending March 27, 1888. Highest.	Lowest.
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	38½ 39½	3 9 7	Jan., Apr., July, Oct.	39	...
2,614,820	Stock	20/0	Do. Preferred	65 66	4 5 4	,, ,,	65½	65
2,614,820	Stock	nil.	Do. Deferred	13½ 14½	...	February	13¾	...
130,000	£10	3/0	Brazilian Submarine	12 12¼	5 14 3	Mar., June, Oct., Dec.	12¼	12 1/16
16,000	10	8/0	Cuba Submarine	12½ 13	6 6 0	February and August	...	...
6,000	10	10/0	Do. Preference	18½ 19½	5 5 3	,, ,,	19½	9¼
		2½	Direct Spanish	3½ 4	...	...	...	...
6,000	5	5/0	Do. Preference	8½ 9½	...	April and October	8¾	...
60,710	20	2/0	Direct United States	8½ 8¾	4 8 0	Jan., Apr., July, Oct.	...	...
380,000	10	2/6	Eastern	11½ 11¾	4 13 7	,, ,,	11¾	11⅞
70,000	10	3/0	Do. 6 per Cent. Preference	14½ 15½	3 17 5	,, ,,	15⅝	14 13/16
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	4 10 1	February & August	...	...
250,000	10	2/6	Eastern Extension	12½ 12¾	4 14 1	Jan., Apr., July, Oct	12⅞	12⅛
22,050	10	5/9	German Union Telegraph and Trust	9¼ 9¾	6 3 1	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅝ 5⅞	4 18 0	Jan., Apr., July, Oct.	5⅞	5⅝
178,992	10	3/0	Do. 6 per Cent Preference	13¾ 14	4 5 9	,, ,,	13⅞	13⅝
150,000	10	5%	Great Northern	13¾ 14¼	5 5 6	Jan., July, and April	14	...
17,000	25	5%	Indo-European	38 40	6 5 0	April and October	...	...
			London Platino Brazilian	5 5½	...	...	...	...
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October	7¾	...
338,225	Stock	15½%	Submarine	135 145	9 9 0	February & August	143½	142
30,000	10	6/0	West Coast of America	5¼ 5¾	8 13 9	January and July	...	...
			Do. Debentures	111 116	...	...	...	...
88,321	10	nil.	West India and Panama	¾ 1	...	...	...	...
34,563	10	9/0	Do. 1st Preference	10¼ 10¾	5 11 7	April and October	10 11/16	10⅝
45,181	15	3/9	Western Brazilian	9¾ 10	4 5 10	March & September	9 13/16	9⅞
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅞ 1⅛	5 9 0	Yearly	...	...
			Oriental	¼ ½	...	...	...	...
80,000	£5	5/0	United	13¾ 14¼	4 11 3	June and December	14 3/16	13 15/16
			United River Plate	4¾ 5¼	...	...	...	...
			ELECTRIC LIGHT.					
	5		Anglo-American Brush (£4 paid)	2¾ 3¼	...	...	2 13/16	2¾
23,692	5	nil.	Do. (fully paid)	3¾ 4¼	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅛ 2⅜	...	...	2⅜	2 3/16
312,000	¼	5% '86	Maxim-Weston	⅛ ¼	...	February	⅛	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	6 1 3	March and July	39¼	39⅛
41,600	10	40/0	India Rubber, Gutta Percha, & Telegraph Works	15 17	5 17 8	February & August	16¼	16⅛

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

Although three judges dissented from the finding of the Court in the case of the American Bell Telephone Company, commented on in our leading article this week, it should be noticed that the dissent relates only to that part of the case with which Drawbaugh's alleged invention was concerned. On all the other points the Court seems to have been unanimous, and even on this the dissentient judges cast no doubt upon the independence of Bell's discovery, but are unable to dismiss the whole of Drawbaugh's witnesses as untrustworthy.

The language employed by Mr. Justice Bradley, however, in favour of Drawbaugh's claims is itself decisively against their legal validity. The following passage will sufficiently illustrate our meaning:—"He (Bell) was a man whose professional experience and whose scientific attainments enabled him to see at a glance the importance of it (the telephone). Drawbaugh was a different sort of man. He did not see it. Had he done so he would have taken measures to interest persons with him in it and have brought it out." According to our patent law the man who sees, and acts on what he sees, is alone entitled to a patent; and Drawbaugh in an English court could only have established his own claims by destroying his title to a patent, publicity and usage being fatal to exclusive rights.

But without reference to English patent law it is evident that except for Bell's successful discovery the world would never have heard anything of Drawbaugh's magneto telephone, supposing he ever invented one—which is supposing a great deal. It follows that we owe both the discovery and its application to Bell; to Drawbaugh we owe absolutely nothing. To transfer the ownership in the invention from Bell to Drawbaugh would therefore have been grossly unfair in any case; but to do so on the testimony of a parcel of ignorant villagers would have been absurd.

Some three months ago we stated that negotiations had been set on foot with a view to effect a re-amalgamation between the United Telephone Company and its various offshoots. Some progress has been made since then, and the *Financial News* of Wednesday last contained the following:—

"This is an age of grand amalgamations, and another is on the carpet. The various telephone companies are now negotiating for a fusion of interests. Being already very closely related, they should have no difficulty in drawing the cord still closer. So far the negotiations have proceeded very smoothly, and, though not yet completed, a successful issue to them may be confidently predicted. A good deal more is, we believe, contemplated than mere combination. Better working arrangements in the metropolitan area will be an essential part of the scheme. Another incidental reform will be a classification of the new capital adapted to various classes of investors. By putting so much in debentures and so much in preference shares, the return on the ordinary can be greatly increased, even on the basis of present revenue. There are, moreover, experienced telephone men who predict that a little more enterprise exhibited in certain directions would speedily increase the revenue by 50 per cent. at least. These are slight prognostications of a very big scheme, about which we may have more to tell shortly."

Under the title of "How They Do It in England," the New York *Electrical Review* publishes an interesting communication from "An Observer." As wise men we are all of us glad of an opportunity to see ourselves as others see us, so that no apology need be made for reprinting the following passages from this 'cute observer's criticism:—

"Quite an interesting tableau is presented to the quiet observer on a careful perusal of the proceedings of the English Society of Telegraph-Engineers, at their meeting of February 9th, 1888.

"First, Mr. Knapp (*sic*), a high electrical authority and cup bearer to the amber god, stood up loaded to the muzzle with core and shell transformers, whose differences and peculiarities he discussed in his usual forcible and logical methods. He told of the idiosyncrasies of the healthy adult transformer; and he gradually warmed up to the task of tackling the diseases, such as 'static hysteresis,' and 'viscous hysteresis,' and 'dissipated energy,' and magnetic resistance to good behaviour, &c. Altogether his paper was most interesting.

"Mr. Knapp stands, as it were, with one foot in direct-current territory, the other in the field of transformers, and reaches for safety fuses with both hands.

"Next comes our old acquaintance, Prof. Ayrton, the renowned maker of mysterious ammeters, voltmeters, ohmmeters, and a whole tribe of other meters, including everything but a common-sense meter, capable of being taken apart, repaired, and reliably calibrated by the owner. He wanders anxiously through the dark wilderness of instrumentation with the light of criticism, like Diogenes with his candle, looking for an honest meter. True to his instinct he *finds* it (Invenio: I come upon, I *invent*), and how beautifully simple and English it is, to be sure.

"Then, after a few scattering observations by eminent members of the society, the adjournment being at hand, Mr. Crompton fiercely satirises the previous remarks of the various

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speakers, and notifies them that his gun, too, is loaded, and at the next meeting he proposes to demolish them with their transformers and blackboard mathematics from a purely commercial standpoint. At the reconvening of the society, the adiourned discussion was taken up, and the wreckers began their work. Mr. J. E. H. Gordon, the hitherto great champion of alternating-current direct distribution, thought it a great pity to see so much ingenuity lavished on that *ignis fatuus* of the electrical engineer—the transformer system—which, it is true, is of great scientific interest, but of no practical value, only intended for a makeshift, &c. He abandons his cherished theory about direct distribution, and comes out strongly in favour of distribution by storage batteries. Why? Because it does not pay to run a 20,000-light dynamo for twenty-four hours, when the whole number of lights is called for only during a few hours—say, 4 to 10 p.m. It is bad for the coal pile. Certainly, Mr. Gordon, but the conclusion does not form a necessary sequence that storage is the *summum bonum.* The arguments against 5,000 horse-power quadruple expansion engines are good, but why use them? Under Mr. Church's plan of lamp-hour-proportioned engines and dynamos, the argument fails.

"Finally, the great Crompton begins his work of demolition. With true British superciliousness he ridicules everything that everybody else asserts, runs down their efforts and results, and insists that they have a little to learn still in the way of electric lighting. He has 'carried out several central stations;' *ergo* he knows it all. Such egotism is only equalled by the taste displayed in the following remarks :—

"Anybody who has been to America, and knows anything about American installations, will corroborate me in saying that the electric light machinery as made in the shop is perfection, but the putting up of it is such as would not pass muster in the worst of our English installations. That has been the case with the transformers set up by Mr. Westinghouse, and though perfectly suitable for such countries as America and Australia, where rough workmanship and rough things do, they are quite unsuitable for a civilised town . . . ."

The letter concludes with some remarks which lead us to fear that the writer is not able to sufficiently discriminate the wheat from the chaff—unless, indeed, in his case it is all chaff. These are his concluding words :—

"But in all this there is a lesson for Americans. For years most of the scientific text-books have emanated from abroad. In the literature of electric lighting we have been largely accustomed to depend upon the supposed superior erudition of our English cousins, and to accept their theories, elucidations, and conclusions as final and correct. But the spectacle of inconsistency, recrimination, and disagreement in vital questions presented at the last meeting of the Society of Telegraph-Engineers and Electricians shatters our idol and opens our eyes to the species of idolatry we have been practising. After all, though we have read their books, studied their theories, and some of us have been misled by their conclusions, if our work is summed up for judgment, it must be said we are ahead. Our American electrician gets an idea, and he does not sit down for a week's wrestling match with sines and cosines, hyperbolic logarithms, or other mathematical sinuosities, but *goes to work* and reduces the idea to practical form, and thus makes more progress in one week than his English contemporary will in a year. Nor do our best electrical engineers waste their time in useless discussions in the domain of exalted mathematics as to whether or not such and such results can be accomplished by a formula with a 'constant' tacked to its tail, compelling a year's work to find the constant. They get there sooner with a footrule and T-square, but they get there just the same."

OUR esteemed contemporary *Engineering* has taken up a brief in favour of the installation rules just promulgated by the Guardian Fire Office and the Westminster Fire Office. We have nothing whatever to say against these rules, so far as their intrinsic merit is concerned; in fact, for the most part they might be taken as a condensed and abbreviated edition of the Phœnix Rules. Our contemporary is, however, inclined to value these rules chiefly on the ground of the absence of permissive clauses, and of all reference to the dispensing power of the inspector. This question is undoubtedly one of the most important and one of the most difficult which has to be dealt with, and the conflict of opinion upon the subject will certainly be very great. It is evidently quite impossible to frame a set of rules which shall provide for every possible contingency or condition which may arise in the whole field of electrical engineering, and we take it that even our contemporary will admit that any rules which aim at universal acceptance must in some way provide for circumstances of an exceptional character. The objection to the dispensory clauses in the Phœnix Fire Office Rules arises, we think, chiefly from the fact that their too frequent introduction imports an air of uncertainty and self-distrust to the whole set. Besides this, to a contractor who is inclined to scamp his work it opens up the possibility of getting a remission in the stringency of the regulations in places where, but for the appearance of the dispensory clause, it might never have occurred to him. It seems to us that the best plan would be to omit the references in the several clauses, and insert a final paragraph to the effect that whenever it is desired to make any departure from the strict letter of the rules special application must be made.

WE have already expressed regret that the subject of fire risks should have been still further complicated at a moment when the long-deferred report of the Committee of the Council of the Society of Telegraph-Engineers and Electricians is about to appear. Still more do we regret the uncompromising and even acrimonious tone which several of the disputants have seen fit to adopt. The question is, in fact, a difficult one, and a practical solution will only be obtained by a determined effort to arrive at an amicable understanding all round.

IT is comparatively easy to be wise after the event, but it may be none the less useful to remark that the present dissensions would probably never have arisen if the Council of the Society of Telegraph-Engineers and Electricians had seen fit to take the Members and Associates of the Society a little further into its confidence. A practical question such as that of fire risks, into which the commercial element so largely enters, might well have been discussed at a special meeting of the Society in committee of the whole house. This would have given every one concerned an opportunity of stating their own special views and opinions, and would no doubt

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have led to the appointment of a sub-committee, consisting chiefly of the men whose interests were most nearly affected. There would then have been no excuse for saying that such a body of practical men, armed with the imprimatur of the Society, was not thoroughly competent to deal with the question, and also thoroughly representative of the industries affected. And there would probably have been little or no difficulty in arriving at an agreement jointly and severally with the Fire Insurance Offices. It is probably too late or too soon for this course to be adopted at the present time. But it is not clear in what other way a final solution can be arrived at.

WOULD it be unreasonable to suggest that the various Committees appointed by the Council of the Society of Telegraph-Engineers and Electricians should report progress at the Annual General Meeting of the Society? There are in existence at the present time, we believe, several Committees which have been appointed to deal with various subjects of considerable importance to the electrical world; of these we need only mention, besides the Fire Risks Committee, that on Standardising Instruments, and on Nomenclature and Notation. But with the exception of the first-named—which was itself at one time reported to have expired of inanition—nobody outside the Council has probably the least idea as to when, if ever, they may be expected to present a report. Many members of the Society are probably even unaware of their existence. Information on the subject may, for anything we know to the contrary, be obtainable on application to the ever-courteous Secretary of the Society; but seeing that the deliberations of these Committees frequently extend over years of, doubtless, arduous labour, we really think that it is due, no less to the Members of the Committees themselves than to the Society at large, that the progress of their deliberations should from time to time be made known. So long as no one knows either what Committees there are, who are on them, or what is being done, it is impossible to display as much gratitude, or even to feel as much confidence in the results of their labours as we naturally desire to do.

WE wonder whether the Nomenclature Committee has yet had under consideration the really important and pressing question of the desirability or non-desirability of the term "Magnetic-Resistance." Those who have to write much on technical matters would certainly feel thankful for an authoritative decision on this point; only if we are not to use this term we hope we shall be told what we are to use instead.

A REMARK of *The Times* correspondent with the Easter manœuvres, to the effect that there was always considerable danger of the opposing armies reading each other's flag signals, reminds us of a safeguard which perhaps we ought to have mentioned in our recent article on Electric Defences. There is, as we have said, an immense advantage in having a uniform code of signals, the Morse being on the whole the best, because most widely known. But for that very reason provision should be made against a time of war, when, although the alphabet remain the same, the words signalled shall mean something different, and be intelligible only to friends. A secret language of the kind here referred to has long existed in the navy; but we are not aware that the army is similarly provided, although for either flag signalling in face of the enemy, or electric signalling over country occupied or threatened by the enemy's scouts, a similar necessity for secresy would obviously arise.

WE were very pleased to hear Prof. Silvanus Thompson, at the last meeting of the Society of Telegraph-Engineers, speak so highly of Mr. F. C. Webb's little book on "Electric Induction." The book has been out of print for many years—we believe that only a very small edition was printed in the first instance—and we happen to know that as much as a guinea has been given recently for a copy. It was written some twenty-six years ago, and it is scarcely too much to say that the author was at least thirty years in advance of his age; we mean, of course, as measured by the average electrical knowledge of the profession.

Beziers (France).—The Gas Company of this town is about to supply an electric lighting installation for lighting the theatres.

The Welsh Gold Mines.—Electric lighting apparatus is now in course of erection at the gold mine at Gwynfynydd which is to be worked both night and day.

Postal Telegraph Appointment.—Mr. E. Ashton has been appointed Superintending Engineer of the Western District of Scotland in the place of Mr. Tansley, deceased.

Madrid.—On Saturday last the new regulations for the theatres of Madrid were published. The use of gas is entirely prohibited, and the adoption of the electric light within six months is made compulsory.

Tenders Required.—We would direct attention to the announcements of contracts for electric lighting *materiel* required at Bradford and Edinburgh, which will be found in our advertisement columns.

Edison versus Westinghouse.—The United States District Court at Pittsburg has given a "preliminary decision" in favour of the Westinghouse Electric Light Company in the suit brought by the Edison Company.

The "Ingeniero Civil"—We have received the first number of the *Ingeniero Civil*, of Buenos Ayres, a new fortnightly illustrated paper, which is to be the official organ of the Society of Civil Engineers of the Argentine Republic.

Lighting of the Suez Canal.—The Suez Canal is to be lit by means of compressed oil gas. The regulations concerning the electric lights to be carried by steamers in passing through the canal at night will remain in force as heretofore.

Cheltenham.—The special committee of the Cheltenham Town Council which has been appointed to draw up a report on the subject of electric lighting last week paid a visit to Taunton and inspected the Thomson-Houston installation in that town.

The Cornell University.—We have received a copy of the "Register for 1887-8" of this excellent institution at Ithaca, N.Y., giving a full account of the foundation of the University, its administration, equipment, and methods of teaching. The provision for electrical engineering students appears to be ample and appropriate.

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Important Sale.—On the 17th, 18th, 19th, and 20th of April Messrs. Wheatley Kirk, Price and Goulty will sell by auction at Liverpool the whole of the iron and other buildings recently employed for the Exhibition, and also a large quantity of furniture, fixtures, timber, &c. Full particulars will be found in our advertising columns.

Barcelona Exhibition.—We are informed that the Anglo American Brush Electric Light Corporation have concluded a contract with the authorities of the Barcelona Exhibition for the erection and running of illuminated fountains similar to those which were an object of so much interest and attraction at the South Kensington Exhibitions.

Paris.—The firm of Mildé fils et Cie. has issued a circular which states that in view of the conditions imposed by the Municipal Council they are compelled to abandon their scheme for an electric lighting station in the districts of the Plaine Monceau and the Champs Elysées.—The first Thomson-Houston installation carried out in Paris, consisting of 30 arcs, will shortly commence work at an establishment in the Boulevard des Capucines.

Lighting Contract open at Konigsberg.—The British Consul at Königsberg announces that the municipal authorities of that town are advertising for tenders for the construction and maintenance of the necessary works for lighting the streets with the electric light. A copy of the conditions, with a plan of the city, can be obtained from the chief cashier of the municipality on payment of two and a-half marks, and tenders will be received until the 16th April next.

House Lighting.—The contract for lighting The Hawkhills, Easingwold, Yorkshire, the residence of Mr. J. H. Love, has been placed in the hands of the United Electrical Engineering Company (Limited). The installation will consist of about 200 16 candle-power lamps. The power will be supplied from a steam-engine and boiler to be erected by the contractor in a small engine-house built for the purpose, and a set of accumulators will be provided to keep 90 to 100 lamps running from eight to nine hours.

Copper.—*The Statist* has an interesting article on the demand for copper, enumerating four main sections—telegraphy, marine steam engines, locomotive engines, and brass fittings, &c. The conclusion appears to be warranted that the rise in the price of copper will almost certainly lead to the substitution of copper-coated iron for various purposes; but meanwhile the monthly deliveries of copper in France and England continued small during March, and stocks are accumulating on the hands of the syndicate.

Telephone Contract in Peru.—There are, we believe, no patent laws in Peru, but the Government has nevertheless decided to grant a concession for the exclusive rights to erect and maintain telephone lines and exchanges in that country for a period of fifteen years. The concession will be awarded to the contractor who offers to work at the lowest tariff for exchange communication. He will have permission to erect overhead lines, and to fix poles upon the roofs of the public edifices. Tenders will be received at Lima up to the 14th May.

The American Telephone Suits.—Our monthly contemporary, the *Electrical Engineer* of New York, has issued a special supplement containing a verbatim report of the judgment of the United States Supreme Court, delivered on the 19th ult. in the appeals against the Bell Telephone Patent, together with the opinion of the three judges who dissented from the views of the majority. We shall reprint this judgment, the first portion of which appears in another part of our present issue.

University College, Bristol.—The Students' Engineering Society of this College concluded the winter session on March 26th with a public disputation "On the Gas Engine *v.* the Steam Engine," and on March 27th with a *conversazione.* Mr. de Soyres occupied the chair on the first night, and Mr. Albert Fry on the second. The electrical and engineering exhibits attracted much attention, and a highly appreciated concert was rendered by the students and their friends. The proceedings were concluded by a short address to the departing members by Dr. Ryan, President of the Society.

The Conductivity of Boiling Sulphur.—M. Duter contributes to the *Comptes Rendus* a note in which he describes some experiments undertaken in order to see whether a current could be made to pass through sulphur maintained at the boiling point. He found that electrodes of platinum were attacked, and it was therefore necessary to use pure gold. By the aid of a copper voltameter placed in series he measured the number of coulombs passed through by means of a Ruhmkorff coil and a set of Leyden jars. At the end of eight hours he found that the increase of weight of the copper cathode was equivalent to the passage of a current of 0·0008 ampere. The specific resistance was not, however, ascertained.

Recent Improvements in Telephony.—The fortnightly meeting of the East of Scotland Engineering Association was held last Tuesday. Mr. A. R. Bennet, M.S.T.E. and E., of the National Telephone Company, read a Paper "On Some Recent Improvements in Telephony." After describing the duplex and quadruplex systems of telegraphy, Mr. Bennet showed that by an extension of the same methods applied to telephones the conveyance of two independent and simultaneous messages over the same wires, either in the same or opposite directions, was possible, and that without impairing the efficiency of the speaking. The Paper was profusely illustrated with diagrams and apparatus. Mr. Bennet received a cordial vote of thanks for his Paper.

Postal Telegraph Revenue.—The Revenue Returns for the financial year ended 31st March, 1888, show a continued increase of the receipts derived from the telegraph service. For the quarter ending June 30, 1887, the gross revenue amounted to £465,000, against £425,000 for the corresponding period in 1886. For the September quarter they were £540,000, the same quarter in 1886 yielding £515,000. The quarter ending 31st December, 1887, produced £465,000, as compared with £445,000 in the same quarter of 1886. For the fourth quarter just ended the receipts were £480,000, those for the corresponding period of 1887 being £445,000. Thus the total for 1887-8 was £1,950,000, against £1,830,000 for 1886-7, being an increase of £120,000.

Leamington.—Owing to the dissatisfaction expressed at the electric lighting on the Parade at Leamington, further alterations and improvements are about to be introduced by the Midland Electric Lighting Company. It is proposed to substitute, in place of the 16 candle-power Swan lamps now in use, 32 candle-power Edison lamps, and to reduce the number of lamp-posts by about one half. An alteration is also to be effected in the mode of hanging the lamps, which will not be suspended from the end of a long arm, but will be enclosed in a globe placed on the top of the supporting column. The globe will be 2ft. in diameter; the upper part opal, and the lower part frosted glass. The shape of the lamp will thus be hidden, and only the light coming from the globe on all sides will be seen.

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Prize Offered by the Belgian Society of Electricians.—The Belgian Society of Eletricians offers a prize of 250fr. for the best essay on the elementary principles of electricity. The competition is open to anyone who is employed in the electrical industries, but is intended primarily for operators or mechanics, and not for those who have received a technical education. Algebraic formulæ are not to be employed, but may be given in a separate appendix. In general the demonstration of the fundamental laws need not be given, and the science of magnetism is not to be entered upon any further than is necessary for the explanation of electro-magnetism. The essays must be written in French, and will be received up to January 1st, 1889; further information may be obtained from M. E. Lagrange, Secretary to the Society, 26, Rue Vilain XIII., Brussels.

The "Phil. Mag."—The following electrical papers will be found in the *Philosophical Magazine* for April:—"Note on the Electromotive Force in Moving Conductors," by H. W. Watson; Experiments on Electrolysis—Part I. "Change of Density of the Electrolyte at the Electrodes," by W. W. Haldane Gee, B.Sc., Assistant Lecturer in Physics, and H. Holden, B.Sc., Bishop Berkley Fellow in Physics, of the Owens College, Manchester; "On a Modified Water-Dropping Influence Machine," by Prof. Silvanus P. Thompson, D.Sc.; "The Effect of Magnetisation on the Thermo-Electrical and other Physical Properties of Bismuth," by Herbert Tomlinson, B.A.; "On a Method of Determining the Difference between the Phase of Two Harmonic Currents of Electricity having the Same Period," by Thomas H. Blakesley, M.A.; "On Some Electrical Phenomena Provoked by Radiation," by Prof. A. Righi.

The Proposed Electric Lighting of Exeter.—At the meeting of the Exeter Town Council last week a memorial in favour of lighting the streets of the city by electricity was presented by a deputation from a public meeting held on the 21st ult., at which a resolution was passed to the effect that, "in view of the great satisfaction given by the recent lighting of the streets of Exeter by electricity, it would be in the interests of the city, and add to its attractiveness and prosperity if the principal streets were lit with the system of arc lighting now in use"—the Thomson-Houston. The memorial, to which no less than 3,000 signatures were appended, was referred to a committee of the whole council, as was also a letter from Mr. H. W. Michelmore, secretary of the Exeter Electric Light Company, notifying the intention of the directors to submit a tender for lighting the principal streets of the city by electricity, and incidentally mentioning that the system was as cheap as gas.

The Alleged Electrical Fire at Lucerne.—Some further particulars are now to hand concerning the destruction by fire of the Gütsch Hotel at Lucerne, which was at first rumoured to have been due to the electric light installation. At the inquest which has since been held it was, however, conclusively shown that this was not the case; although the transformer was supplied with fusible cut-outs, yet the lamps were burning as usual half-an-hour after the outbreak. Local opinion never endorsed the rumour, which only appeared in journals published at a distance. Other hotel keepers in the town who are using the electric light are quite satisfied that the fire was not due to this cause. The inquiry did not throw much light on the true origin of the disaster, though it is believed that a plumber who was at work on the roof the night before had something to do with it. The proprietor of the Central Station at Lucerne since the date of the fire has ordered a third dynamo from MM. Ganz and Co., of Buda-Pesth.

Electric Lighting of Trains.—A number of gentlemen interested in the lighting of railway carriages electrically, on the invitation of Mr. John Noble, general manager of the Midland Railway Company, have recently visited their works at Derby, to witness the working between that town and Manchester of the system of electric lighting of railway carriages designed by Mr. J. A. Timmis. The chief feature of the system is that it secures "through lighting" in a train by the adoption of the Union battery stored in each vehicle, and by this means any carriage may be put into a siding, or be slipped from a train, without interfering with the maintenance of the light. In case one or more of the vehicles are slipped or break loose from a train, the lamps in them, if lit, remain lighted, and if they are not lit provision is made for their being automatically lighted up. The London and Brighton Railway Company have now 15 trains lighted by electricity, two running between London and Brighton, the 13 others being local ones.

A Strike the Result of Bad Lighting.—A strike has recently occurred among the operatives at the textile manufactory of Tarpassa, in Catalonia. The Barcelona correspondent of the Madrid paper, *El Imparcial*, has been investigating the case on the spot, and he writes that the difficulties arose owing to the fact that the Alcalde and sanitary inspectors, having visited one of the factories, ordered the suspension of work owing to the very bad quality of the gas, and the consequent unhealthy condition of the rooms. The quality of the gas having been improved, and work resumed, the manufacturers imposed a condition on the workpeople to make up for the hours lost during the time the factory was closed, or else that there should be a deduction from the wages. The workpeople objected to this, and the difficulty led to a general strike. If the quality of gas employed on the Continent is so very impure that the sanitary authorities have to interfere, surely there ought to be not only plenty of scope for the introduction of the electric light, but every facility offered to induce engineers to supply the want.

Electric Coal-Cutting Machine.—The application of an electric motor to coal-cutting machinery has been carried out by Messrs. Bower, Blackburn and Mori, of Woodlesford. The framework or bed-plate of the machine is supported on wheels. Within the framework is mounted or applied the electric motor, which may be of any suitable construction. A rotary motion is transmitted to the shaft carrying the cutter bar through gearing. The lower part of the framework forms a circular turntable, and is fitted so as to be capable of a rotary movement on the bed-plate, this rotary movement being effected by means of a worm, mounted on a shaft, supported in the bearing, attached to suitable brackets, mounted on the bed-plate, and worm-wheel segment, attached to the upper part of the framework. By this means the cutter bar can be moved along by the attendant as the coal is being cut, and the proper feed given thereto. Although by preference the motor is carried on or attached to the coal-cutting machine, it may of course be placed at any convenient distance therefrom, and motion transmitted from such motor to the machine by gearing.

Bradford.—The Electric Lighting Contracts.—The scheme to be submitted to the Bradford Town Council for the lighting of the borough by the electric light has been adopted by the Gas Committee of the Corporation. The plans, &c., have been prepared by Mr. J. N. Shoolbred, C.E., the electrical engineer to the Corporation, who has also had the assistance of Dr. Hopkinson as consulting engineer. The generating station, as previously stated, will be erected on a site in Bolton-road belong-

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ing to the Corporation, and substantial buildings of stone will be erected. The motive power will be supplied by three Lancashire boilers, with Galloway tubes, and the boilers will have a working pressure of 140lb. to the square inch. There are to be three sets of steam dynamos, each of which will be driven direct by a separate engine of the inverted vertical type. The three dynamos will have an output of 85,400 watts each, the contractors guaranteeing a commercial efficiency of 75 per cent. The conductors will be encased in lead, and the covering will be both chemical and waterproof. The area of supply will be restricted at the outset to the central portions of the town, but provision is made for considerable extensions. Contracts for the necessary works are to be received up to the 25th prox., and it is thought their execution will be completed by the end of September next.

Southampton.—On the evening of Monday, the 26th ult., the Mayor and a strong body of the Corporation of Southampton visited the sanitary works at Chapel for the purpose of inspecting the installation of the electric light in connection with the destructor. The work has been carried out by Mr. A. J. Baron under the direction of Mr. W. B. G. Bennett, the borough surveyor. Mr. Bennett explained to the Mayor and members of the Corporation present the mode of working the destructor, and pointed out that the existing boilers and engines might be employed as a means of power for lighting a large area round the works with arc lamps, and the Guildhall, Hartley Institute, and the Audit House with incandescents. It was stated that a saving could be made to the ratepayers over the present cost of gas of upwards of £100 per annum, with an increased amount of light in the streets and buildings mentioned. The Mayor and Corporation were unanimous in their approval of the success of the trial, and the Chairman of the Special Works Committee was instructed at the last Council meeting to bring up a detailed report of the same on Wednesday next, when an important discussion will take place. As an outcome of the experiments Mr. Bennett has received numerous inquiries from the borough surveyors of other towns concerning the cost of the destructor, together with the working expenses, &c.

Stockholm.—Our correspondent writes:—"A series of interesting trials with electric light have recently taken place at Stockholm, and have given great satisfaction. The Stockholm Gasworks are about to erect a central electric station in the Swedish capital, and have solicited tenders from a number of foreign firms. They also received an offer from the well-known firm of Ganz and Co., Buda-Pesth, and as this system was entirely unknown in Sweden, the company offered to arrange for a trial at its own cost; and this has turned out so well that it has been allowed to go on for some time. There is every reason to expect that the system will be adopted in a great number of cases where there is a question of transmitting the electric light some considerable distance. Sweden seems to offer a very good field for this light, as there are a great many small and large towns where there is plenty of water-power within a feasible distance. At the experiments which have been going on in Stockholm the engine is placed at the gas works, and the total length of the wire is about 2,000 metres; the wire is 4-millimetre copper wire, and is fastened to poles. A couple of large restaurants are lighted by incandescent lamps, and two good-sized arc lamps are placed outside the Opera House. The installation has been effected by the firm of Luth and Roséu, Stockholm, the representatives of Ganz and Co. for Scandinavia."

City and Guilds of London Institute.—An elementary teachers' course of ten lectures and demonstrations in Experimental Physics will be given by Prof. W. E. Ayrton, F.R.S., at the Central Institution, Exhibition-road, S.W., on Saturdays from 10:30 to 12, commencing on Saturday, April 21st, 1888. The aim of this course will be to exemplify the *natural* mode of teaching experimental physics to young students, so that they may learn to grasp the fundamental physical laws and facts, and obtain an elementary working knowledge of the subject. The methods of teaching the various branches of physics found in ordinary text-books will not be followed, but instead, the method which leads the pupils to start from their every-day knowledge of the subject and examine into the laws governing physical phenomena. The importance of teaching *through* the laboratory work of the students themselves, and the possibility of this being done in the case of even quite elementary students, will be fully entered into, and will be illustrated by examples of the way such teaching may be practically carried out so as to impress the more important laws firmly on the students' minds. Methods of constructing comparatively *inexpensive* apparatus, but which, nevertheless, can be used for *quantitative* experimental work, will be treated of in detail. The importance also of designing lecture and laboratory apparatus in accordance with the most recent scientific knowledge, rather than as a representation of the historical apparatus found in text-books, will be fully pointed out.

The International Electrical Laboratory at Paris.—If the recent proposal to found an electrical laboratory in England, under the auspices of the State, and for public purposes, has not been taken up, the advantages of such an institution have, at least, been secured to France by the International Society of Electricians. A central laboratory of electricity has been inaugurated at Grenelle by means of the profits arising from the International Electrical Exhibition of 1881. The sum available amounted to 331,000fr., and was granted by the Minister of Posts and Telegraphs on condition that the interior direction of the laboratory should be in the hands of a telegraph engineer from the State Department of Posts and Telegraphs. The plans were looked after by a committee of ten members of the International Society of Electricians, under the presidency of the president of that body, and M. de Nerville was chosen as director. Additional money was subscribed, and gifts of apparatus were obtained from various manufacturers. The work of the laboratory is divided into two classes—measurements of precision and industrial tests. The former class comprises measurements of resistance, electromotive force, and so on; the latter, tests of cables, batteries, dynamos, and other technical applications. By-and-bye it is hoped that original researches will also be carried out in the laboratory. Pupils are admitted gratuitously according as there is room for them. The laboratory is a large building in the Place Saint Charles, Grenelle, and contains a great variety of apparatus and machines, from delicate experimental instruments to dynamos and motor engines of various kinds, gas and steam. It is, in fact, very well equipped for the work to be done, and with all the latest improvements. A photometric room for testing electric lamps is a special part of the establishment. Moreover, it is in contemplation to build a new and more extensive laboratory later on, when necessity requires it and experience has been gained. One of its principal functions will be the standardising of electrical apparatus so as to secure a uniform comparison of results throughout the country. We may add that a somewhat similar undertaking has been instituted in Brussels, and in all probability the example of France and Belgium will be followed in other countries.

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NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

(*Continued from page 504.*)

Having now seen how the fluctuation of current strength is related to that of the impressed E.M.F. under the conditions of a simple sine law of variation, we pass to the consideration of the measurement of the *power* taken up in such a case.

If the thin line curve in Fig. 28 represent the sinusoidal impressed E.M.F. and the thick white line the corresponding current in an inductive circuit, then at any instant the rate at which energy is being expended on the circuit is equal to the product of the ordinates P M, Q M, which at any point M represent the E.M.F. and current respectively. The mean rate of expenditure of energy, or the *mean power* or *activity* taken up in the circuit is then the mean of all such products taken at very

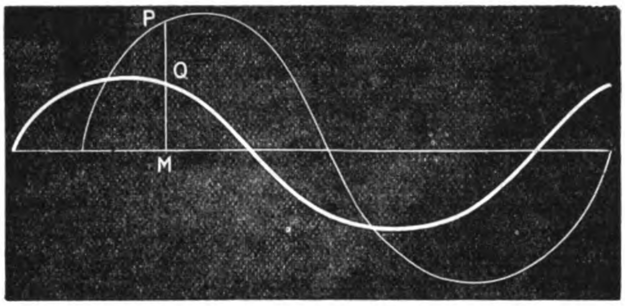

Fig. 28.

numerous and very near intervals. This is not by any means identical with the product of the mean current and mean electromotive force. To arrive at an expression for this mean power we must pave the way by a preliminary proposition on the mean product of two simple periodic quantities. An elegant geometrical proof of this has been given by Mr. Blakesley in his book "Alternating Currents," page 10, *Electrician* series. We shall, however, give here an algebraical proof of this proposition. Let there be two radii O P, O Q (Fig. 29) which revolve in equal periodic times round a common centre O, separated by a fixed angle, P O Q. At equal small intervals of time corresponding to equal angular motions let the projections O p, O q of these lines be taken on a vertical line through O. It is required to find the mean value of the product O p, O q during one complete period.

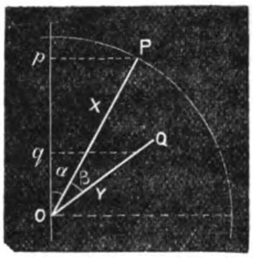

Fig. 29.

Denote by X the length of O P, and by Y the length of O Q, and let the angle P O Q be β, and P O p be α. β is the angle of phase difference, and X and Y are the maximum values of the periodic quantities O p, O q, which are the vertical projections of O P, O Q.

Let O p be denoted by p, and O q by q.

Then $\quad p = X \cos \alpha,$

and $\quad q = Y \cos (\alpha + \beta)$;

and therefore $\quad p\,q = X\,Y \cos \alpha \cos (\alpha + \beta).$

Let the pair of radii O P, O Q be supposed to turn round one complete revolution, proceeding by n jumps, each jump or step increasing the angle α by a very small amount, $\delta\alpha$, and n being a very large number. At each stage let the value of $p\,q$ be measured as above, then the mean value of the product $p\,q$ is one nth part of the sum of all the n values so taken. Call this mean value of the product M. Then,

$$M = \frac{XY}{n}\left\{ \begin{array}{l} \cos \beta + \cos \delta\alpha \cos (\delta\alpha + \beta) + \cos 2\,\delta\alpha \cos (2\,\delta\alpha + \beta) \\ \quad \ldots\ldots + \cos \overline{n-1}\,\delta\alpha \cos (\overline{n-1}\,\delta\alpha + \beta) \end{array} \right\}$$

By trigonometry we have

$$\cos (\overline{n-1}\,\delta\alpha) \cos (\overline{n-1}\,\delta\alpha + \beta) = \tfrac{1}{2} \cos (2\,\overline{n-1}\,\delta\alpha + \beta) + \tfrac{1}{2} \cos \beta,$$

since $\quad \cos \overline{A+B} + \cos \overline{A-B} = 2 \cos A \cos B.$

Accordingly every term, except the first in the cosine series for M, splits up into the sum of two others, one of which is always $\frac{1}{2} \cos \beta$. Rearranging the terms, we get for the value of M as follows :—

$$M = \frac{X\,Y}{n}\left[\tfrac{1}{2}\, n \cos \beta + \tfrac{1}{2}\left(\cos \beta + \cos (2\,\delta\alpha + \beta) + \cos (4\,\delta\alpha + \beta) \ldots\ldots + \cos (2\,\overline{n-1}\,\delta\alpha + \beta) \right) \right]$$

The cosine series in the inner bracket consists of a series of cosines of angles in arithmetic progression taken all round the circle. Hence, since the cosine of any angle is numerically equal to that of the cosine of its supplement, but of opposite sign, these cosine terms will cancel each other out pair and pair, when n becomes very great and $\delta\alpha$ very small, and $n\,\delta\alpha$ equal to $2\,\pi$. For when

$$n\,\delta\alpha = 2\,\pi,\ 2\,\overline{n-1}\,\delta\alpha + \beta = 4\,\pi + \beta, \text{ and } \cos (4\,\pi + \beta) = \cos \beta.$$

The first and last terms of the series are in this case indentical, and for every term there will exist one of equal magnitude and opposite sign. The sum of the series of cosine terms in the inner bracket is accordingly zero.

The value of M reduces them to that of the first term, viz. :—

$$M = \frac{X\,Y}{2} \cos \beta.$$

The mean value of the product of two simple harmonic or periodic functions of equal period but different amplitude and phase, is equal to half the product of their maximum values, and the cosine of the difference of phase.

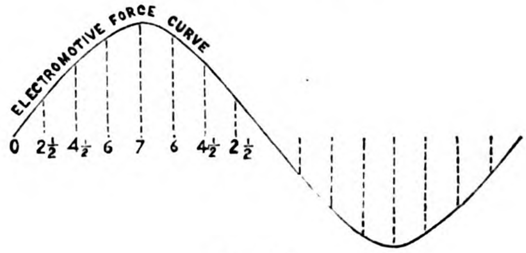

Fig. 30.

Returning to the consideration of the electrical problem, it is now clear that the mean value of the product of the current at any instant and the simultaneous value of the impressed electromotive force on an inductive circuit is obtained by multiplying together half the product of their maximum values, and the cosine of the angle of lag. If i be the current at any instant, and e the impressed E.M.F., I and E being their maximum values, then the mean value of $e\,i$ during a complete period is

$$\frac{E\,I}{2} \cos \theta,$$

and this is a measure of the rate of expenditure of energy on that circuit, or the work expended per second. It is obvious, then, that if the lag is 90°, this mean product is zero, and that no work is done at all.

When θ has intermediate values between 0° and 90° the real rate of dissipation or transformation of energy in the circuit will be intermediate between $\frac{E\,I}{2}$ and zero. In order to understand how this can be and how it is a circuit may be traversed by a current and yet take up no power we must examine a little more closely the nature of the phenomena.

Let the thin periodic curve in Fig. 30 represent a sinusoidal variation of electromotive acting on a circuit which we shall for

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the moment assume has no sensible inductance. Let the thick curve in Fig. 31 represent the corresponding current. The length of each ordinate of the thick curve is equal in magnitude to that of the corresponding ordinate of the thin curve divided by the value of the resistance of the circuit. Let the lengths of corresponding ordinates of these two curves be multiplied together, and the product set off as the ordinates of a new curve represented by the dotted line in Fig. 32. This dotted curve is, then, the curve of *power* or *activity*, and represents the variation of the product, taken at every instant, of the current and the electromotive force.

In multiplying together the ordinates of the thick and thin curves we must pay attention to the algebraic sign of the factors. Ordinates of each curve drawn above the horizontal datum line of the curve must be reckoned *plus*, and ordinates drawn below must be reckoned *minus*, and in taking the product the algebraic law of signs must be regarded. It will then be seen that the dotted line curve consists of a wavy line of two loops lying wholly above the mean datum line. If the area of the two hummocks enclosed by the dotted curve and the

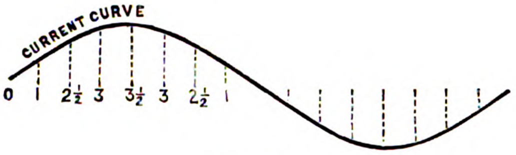

Fig. 31.

horizontal line is *indicated* or integrated, say, by an Amsler's planimeter, the area represented by the shaded part so obtained is a measure of the total work done in one complete period of the current oscillation, and since this area lies wholly above the datum line, it must be reckoned as *positive* or as work done by the electromotive force; in other

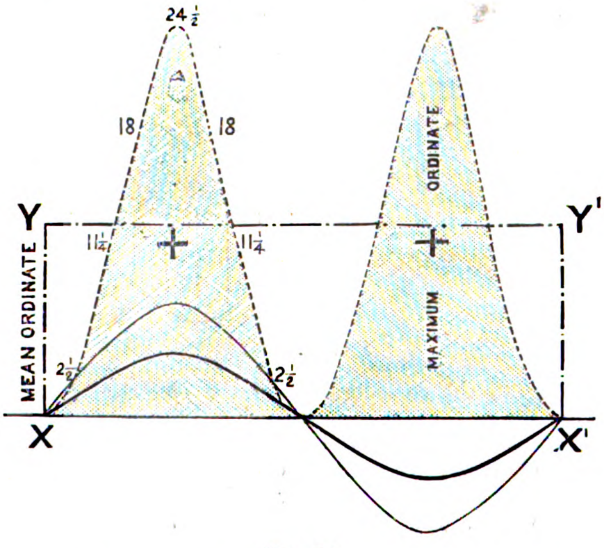

Fig. 32.

Ordinates.	Product.	Ordinates.	Product.
E × C	= P	7 × 3½	= 24½
0 × 0	= 0	6 × 3	= 18
2½ × 1	= 2½	4½ × 2½	= 11¼
4½ × 2½	= 11¼	2½ × 1	= 2½
6 × 3	= 18	0 × 0	= 0

words, it represents the total energy transformed from electrical energy into heat in one complete period.

Next let us suppose that the same periodic electromotive force acts upon a circuit having inductance as well as resistance, and that therefore, as before shown, the current is retarded in phase behind the electromotive force. Let the thin curve in Fig. 33 represent the periodic impressed electromotive force, and the thick curve the current retarded by 45° in phase behind the other. Proceed as before to obtain the power curve by multiplying the heights of corresponding ordinates, the multiplication of the eight ordinates being shown in the margin. We find, then, that the power curve representing the variation of the activity is a wavy curve, consisting of four sections, two large hummocks above the datum line, which are positive areas, and two small ones below, which are negative areas. The algebraic sum taken with regard to sign of all these four areas, represented by the shaded parts, is a measure of the total work done in one complete period by the electromotive force. Going one step more, we may imagine that the current lag is 90°, and in Fig. 34 we have drawn the

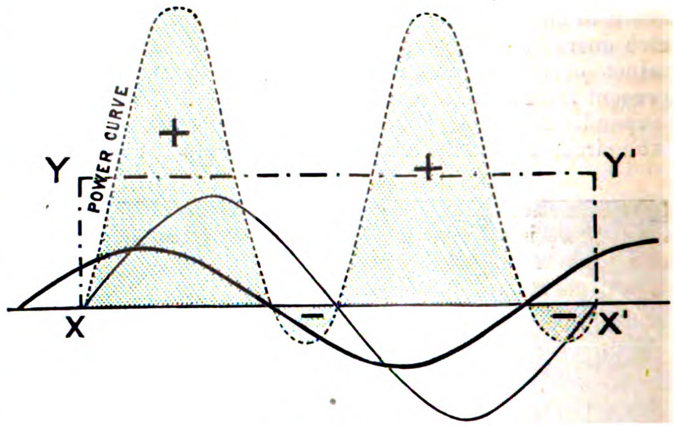

Fig. 33.

Ordinates.	Product.	Ordinates.	Product.
E × C	= P	7 × 2½	= 14½
0 × 2½	= 0	6 × 1	= 6
2½ × 3	= 7½	4½ × 0	= 0
4½ × 3½	= 15½	2½ × −1	= − 2½
6 × 3	= 18	0 × −2½	= 0

power curve in this case, obeying the same instructions. We see that the power curve consists of four loops, two positive and two negative, and that the areas of these hummocks are equal. Hence, the total area or *indicated* value in this last case is zero, and the work done in one complete cycle is zero; hence the rate of doing work, or the power, is zero. Returning to Fig. 32, the first case, it is easy to see that the rate of doing work, or the power, is measured by the *mean ordinate* of the shaded work areas considered as indicator

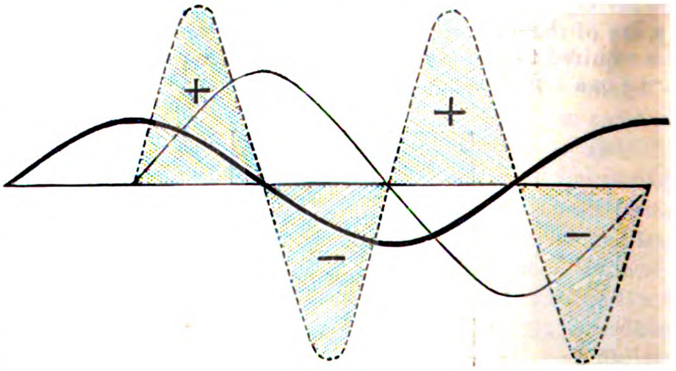

Fig. 34.

Ordinates.	Product.	Ordinates.	Product
E × C	= P	7 × 0	= 0
0 × 3½	= 0	6 × −1	= − 6
2½ × 3	= 7½	4½ × −2½	= − 11¼
4½ × 2½	= 11¼	2½ × −3	= 7½
6 × 1	= 6	0 × −3½	= 0

diagrams. Since the dotted curves are perfectly symmetrical, if we draw a line Y Y″ at half the height of the maximum ordinate of the dotted curve, it will cut the two hummocks into two parts, and the area of the upper part or mountain above the line Y Y′ would just fill up the valley between the bottom parts of the hummocks. Since the rate of doing work is equal to the work done in one complete cycle divided by the time of duration of that cycle it obviously follows that this mean ordinate X Y measures the power or rate of doing work and is equal in magnitude to $\frac{E\,I}{2}$, hence this product is a measure of

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the rate at which the electromotive force does work. Referring to the second case, we see that the mean ordinate X Y is no longer equal to half the maximum ordinate of the positive or upper loop, but is equal to half the difference between the magnitudes of maximum ordinates of the positive and negative loops of the power curve, and is therefore less than $\frac{EI}{2}$. From the proof given previously, we have seen that it is equal to $\frac{EI}{2}$ (cosine of lag).

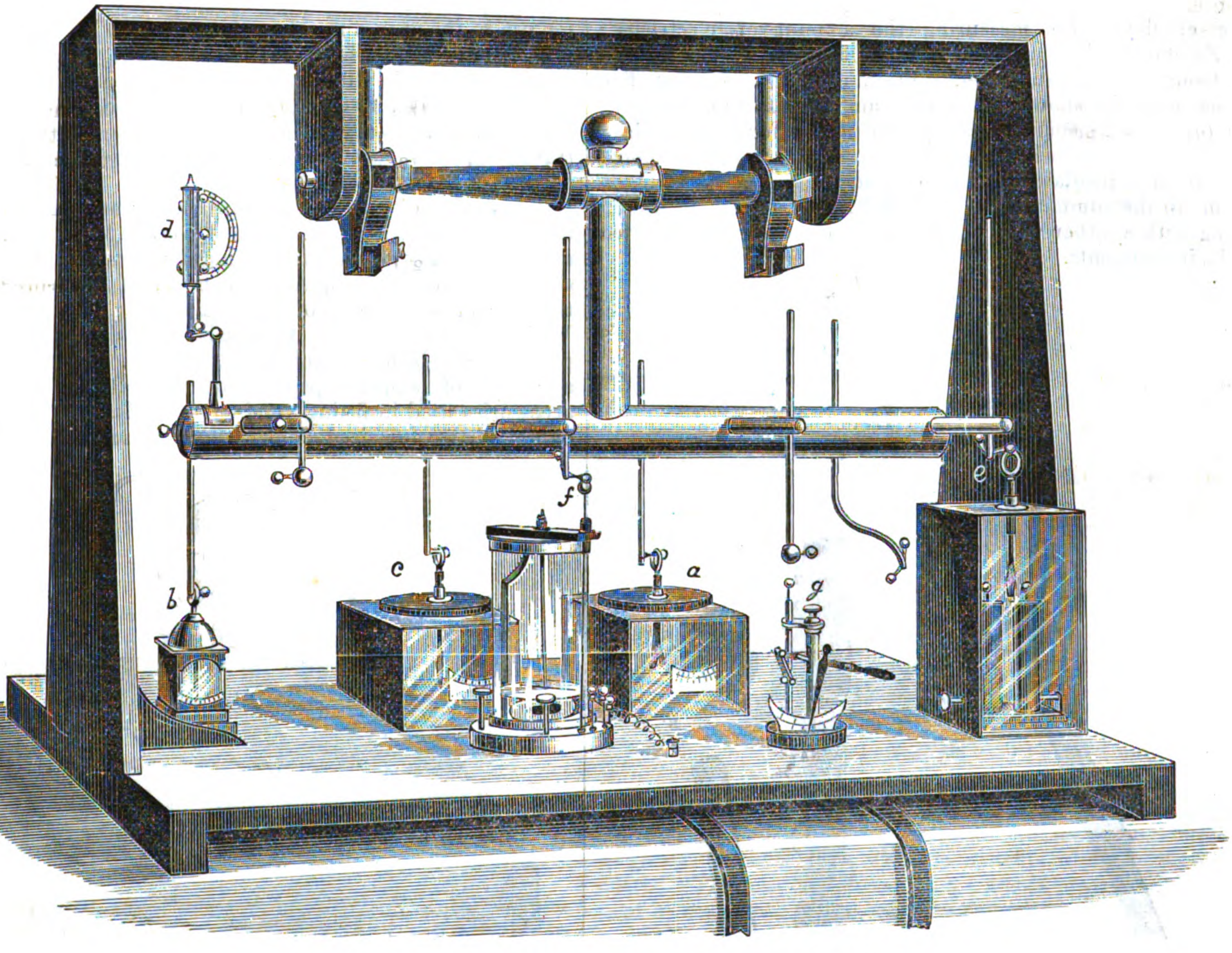
In the third case considered, of a lag of 90 degrees, it is easy to see why the resultant rate of doing work is zero. In the first *quarter of a stroke* the electromotive force propels the current, and this last is in the direction of the E.M.F., but in the second quarter of a stroke the current is negative or opposite to the electromotive force; in other words, the current is moving against the force and does work against the E.M.F., and the same push and re-push is repeated in the second half of the period. Hence, on the whole, though there is an impressed electromotive force and a current flowing, no resultant work is done and no energy dissipated. We may construct a mechanical analogy of this as follows:—

Imagine a steam engine with a heavy fly-wheel working without friction. Let steam be applied to it, the slide-valve being so set that it opens when the piston is at the bottom of the cylinder, and cuts off the steam after a very short fraction of a stroke. Suppose the valve then to remain closed for the rest of the stroke, and that instead of opening to exhaust the cylinder at the end of the stroke the valve remains closed, so that the momentum of the moving fly-wheel drives the piston back and compresses the steam back to its original volume. The valve then is supposed to open and permit the steam to escape at the same pressure at which it entered. Assuming no loss of heat (an altogether hypothetical case), we should then have an engine which absorbs at each stroke a cylinder full of steam; but by which no work is being done. The whole operation is a sort of give and take of energy between the fly-wheel and the steam. The same kind of action is taking place in a circuit acted upon by a simple periodic E.M.F. in which the inductive resistance is so large compared with the ohmic that the lag is 90°. In that case there is no frictional dissipation of energy, but simply a give and take of energy between magnetic field and the source of energy supplying the E.M.F.

(To be continued.)

THE ROYAL METEOROLOGICAL SOCIETY'S EXHIBITION.

BY WILLIAM MARRIOTT, F.R.MET.SOC.



THE ROYAL METEOROLOGICAL SOCIETY'S EXHIBITION.—FIG. 1.

The Royal Meteorological Society's ninth annual exhibition of instruments was held at the Institution of Civil Engineers, 25, Great George-street, Westminster, from March 20th to 23rd. The exhibition was devoted chiefly to instruments connected with atmospheric electricity, and was of a very interesting and popular character. This has been the most successful of the Society's annual exhibitions, and has been visited by many hundreds of persons. We propose in the present and succeeding articles to give our readers a brief account of some of the principal instruments exhibited.

The catalogue comprised 155 exhibits, which were grouped as follows:—Electrometers, lightning conductors, lightning pro

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tectors for telegraph purposes, objects damaged by lightning, alleged thunderbolts, new instruments, photographs of flashes of lightning, and photographs, drawings, &c. The lightning conductors were set out in the Library of the Institution, while the other exhibits were arranged in the two adjoining rooms.

The Astronomer-Royal exhibited the electrical apparatus which was formerly in use at the Royal Observatory, Greenwich. The instruments were mounted on a stand, so as to show the manner in which they were actually arranged for observation (Fig. 1.). These consisted of (*a*) Bennet's gold leaf; Volta's (*b*) light and (*c*) heavy straw; and (*d*) Henley's electrometers, all of which were employed for measuring the amount of electricity; (*e*) Zamboni's dry piles, for showing the kind of electricity; (*f*) Gourjon's galvanometer, containing 2,400 coils of fine copper wire, for showing the kind and amount of electricity; and (*g*) Ronald's spark measurer, for measuring the length of sparks. The exploring copper wire, which was 400ft. long, and carefully insulated, extended from the roof of the Octagon Room to the summit of a mast 80ft. high, thence communicating with another wire, by which the electricity was carried to the instruments.

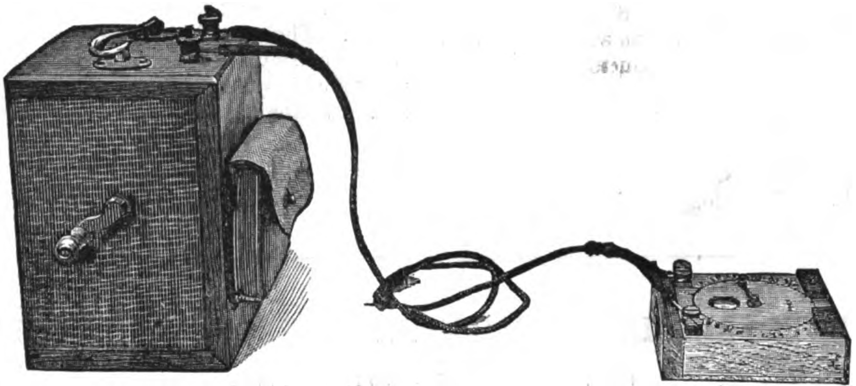

Fig. 2.

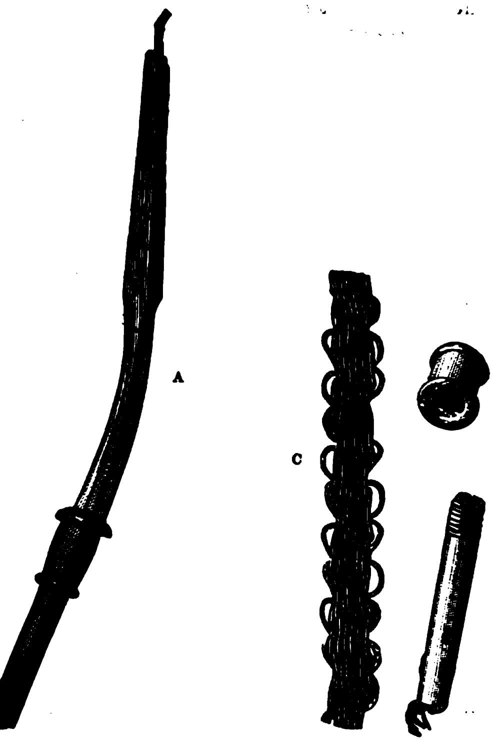

Fig. 3.

The instruments used by Sir Francis Ronalds in the Electrical Observatory maintained during his superintendence of the Kew Observatory, 1843-1851, were shown by the Kew Committee. These included :—Volta's electrometer with straws; Gourjon's galvanometer; various electrographs; Landriani's electrograph as constructed by Ronalds for recording the presence of electrical currents, by fixing powdered chalk in the resinous surface of a disc carried round by clockwork; two dry piles; Wheatstone's modification of Bennet's electrometer; Coulomb's balance; and a portable electrical observatory by Ronalds. A full description of these instruments, with illustrations, is given in the British Association Report for 1844. The Kew Committee also exhibited two forms of Sir William Thomson's portable electrometer, in which the electricity is collected by means of a burning fuse at the extremity of a vertical wire.

Prof. F. Exner, of Vienna, sent his portable apparatus for the observation of atmospheric electricity, which is intended for use in the open air and on journeys. This is a very compact arrangement, the chief parts being a leaf electroscope, gauged from 50 to 200 volts, a stick, with handle to screw on, inlaid with ebony to carry the collector, and the collector. If it should be necessary to calibrate the electroscope afresh while travelling, there are also provided a condenser and a small battery of twenty elements.

A very fine display of lightning conductors was arranged in the library. Messrs. J. W. Gray and Son and Messrs. R. Anderson and Co. exhibited models of churches, houses, and chimney shafts fitted up with lightning conductors in accordance with the recommendations of the Lightning Rod Conference. Various forms of upper terminals with one, three, or four points, some being nickel-plated, were shown, together with specimens of copper tape and rope, as well as all the various accessories used in fitting conductors. Messrs. Gray and Son exhibited two full-sized copper rings, about 5ft. in diameter,

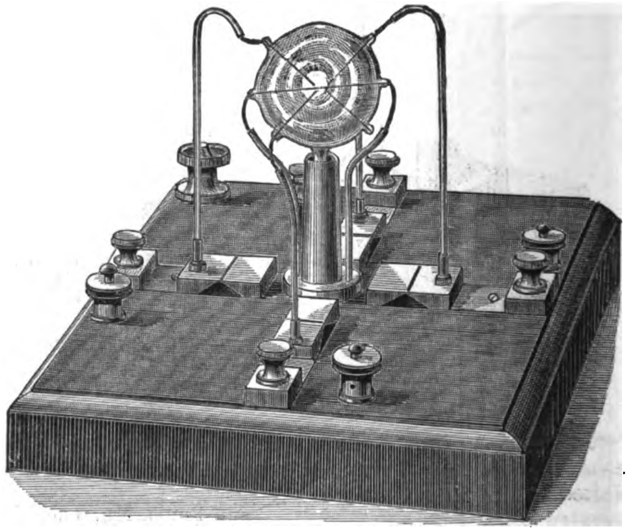

Fig. 4.

with four points to each, as used for factory chimneys; Messrs. Anderson and Co. a coil of copper tape 300ft. long, and Messrs. J. Davis and Son an earth plate consisting of a sheet of copper 3ft. by 2ft. by one-sixteenth of an inch.

Messrs. Siemens Brothers and Co. showed their lightning

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rod testing apparatus, which consists of a magneto-inductor in combination with a testing board (Fig. 2). It is fitted with a galvanometer and other testing appliances, which are all contained in one portable case, and are capable of being used by persons who have no knowledge of electricity. By means of the inductor magneto-electric currents are sent through the lightning rod and earth connection, and the resistance of these is shown on the testing board. A resistance of more than 10 ohms would show that the conductor or earth connection is in such a state as to have become a positive danger, instead of a source of safety, to the building to which it is fixed.

Portions of several conductors damaged by lightning were exhibited, including three which had been sent to the Lightning Rod Conference. Fig. 3 gives a sketch of portions of the conductor which failed at Caterham on May 28, 1879. This shows the upper terminal *a*, the screwed union at which the conductor was fused, *b*, and a portion of the conductor *c*.

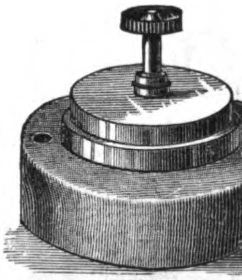


FIG. 5.

The Postal Telegraph Department sent various patterns of lightning protectors used for telegraph purposes. The earliest was Varley's Globe Vacuum Lightning Protector, which was used in 1861 (Fig. 4). A number of platinum points connected to the line-wire are arranged in close proximity to the end of a platinum wire connected to the earth, the whole being enclosed in a small glass globe (through which the wires pass, and into the sides of which the wires are sealed) exhausted of air. Siemens' Plate Protector used in 1865 consists of two corrugated cast-iron plates, the upper one being connected to the line and the lower one to earth. The plates are prevented from touching each other by their ebonite washers. The corrugations on the plates are so cut that those on the one plate are at right angles to those on the other. In the modern circular plate protector used in 1886 (Fig. 5) the plates, which are of small dimensions and circular in form, are separated by a thin sheet of mica, which has three circular perforations in it.

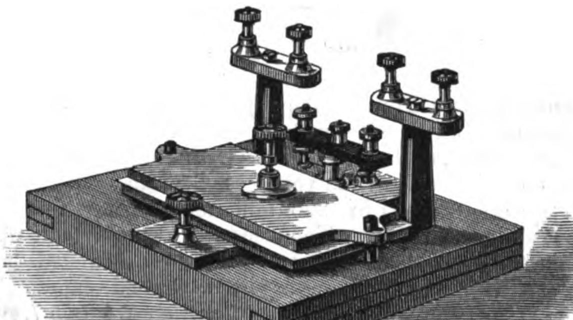


FIG. 6.

Two forms of cable protectors, which are used at the junction point of a submarine cable with a land line, were also exhibited. The earlier instrument, used in 1870, consists of a corrugated plate protector, and also of a silk-covered German silver wire, on circuit with the line, wound on a metal bobbin connected to earth, the whole being covered with paraffin wax to keep out moisture. The later instrument, in use since 1880 (Fig. 6), is similar to the preceding, but has the plates uncorrugated, experiment having proved that corrugations did not increase the efficiency of the arrangement.

(To be continued.)

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER VIII.—*The Calibration of Current Indicators.*

(Continued from page 567.)

100. *The "Calibration Constant" of a Tangent Galvanometer.*—The actual values of the currents on the tangent galvanometer are readily found when the deflection corresponding to one particular current is known, all the others following proportionally from that. For example, the tangent instrument in Fig. 56 requires a current of 2·43 milliamperes to deflect the needle 45 degrees. From this determination, which is easily made by passing a known current through the instrument, we may find the current C corresponding to any other deflection, say 60 degrees, by simple proportion :—

$$C : 2{\cdot}43 :: \tan 60 : \tan 45,$$

and since tan 45 is equal to unity

$$C = \tan 60 \times 2{\cdot}43 = 4{\cdot}21 \text{ milliamperes.}$$

Hence the tangent of any angle of deflection on this galvanometer, multiplied by 2·43, gives the current in milliamperes corresponding to that particular angle of deflection, and the number 2·43 is known as the "*calibration constant*" for this particular tangent instrument. Hence *the calibration constant of a tangent galvanometer is the number which, when multiplied by the tangent of the angle of deflection, gives the current passing, and this number is equal to the current which causes the needle to deflect to 45 degrees.* The values of the tangents of the various angles are found by reference to a table of tangents given at the end of most electrical text-books.

The calibration curve of the indicator may now be plotted in the usual manner, by marking off its angular deflections on the vertical ordinate, and the corresponding currents, determined on the tangent galvanometer as above, on the horizontal ordinate.

If the curve is taken with the object simply of having a record of the relation between currents and deflections, and it is not desired to have the actual values of the currents marked on the ordinate, all that is necessary is to mark out on the horizontal ordinate the tangents of the deflections on the tangent instrument and the corresponding angles of deflection on the indicator on the vertical ordinate. It should be borne in mind, however, that the curve is the same whether the actual values of the currents are determined or not. But it is such an evident advantage to have the actual current values, and so little extra trouble to determine them, that the methods for calibration which are here given include their determination.

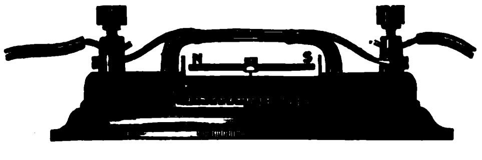


FIG. 58.

101. *Practical Example of Calibration by Comparison.*—In Fig. 58 is shown a current indicator for indicating currents of greater strength than with the instruments previously considered. The needle is shown at *n s*, and is pivotted on a point fixed in the centre of an ordinary compass box marked round in degrees. The coil is of rectangular shape, and consists of a few turns of No. 18 insulated copper wire, the lower half of the coil being let into the wood base. The curve determined for this instrument is shown in Fig. 59. Now, since the currents reach as high as one ampere and over, the cell used for the test and the tangent galvanometer used as an instrument of comparison must both be of low resistance, otherwise we shall not get sufficient current. For example, with one cell of two volts E.M.F. giving one ampere of current the total resistance of instruments and cell could not

exceed two ohms. Hence, the tangent galvanometer used was one with a thick wire coil of a few turns and very low resistance, the cell used was a secondary cell of about $\frac{1}{10}$th of an ohm, and an adjustable resistance frame containing spirals of No. 18 German-silver wire, by which the extra resistance in the circuit could be adjusted from one to twelve ohms, was also included in the circuit. As mentioned above, the actual resistances in the circuit are not taken into account, since the tangent instrument gives the values of the currents. The readings taken were as follows:—

Angles of deflection on indicator.	Currents on tangent galvanometer.
82	1·69 amperes
78	1·3 „
76	1·05 „
74	·92 „
69	·67 „
58	·39 „
37·5	·14 „

From these observations the curve in Fig. 59 is plotted, and as it presented a resemblance to a tangent curve in general form, the writer has worked out a few values for the true tangent curve shown by the dotted lines, by which the wide difference which would be anticipated between this instrument and a true tangent can be seen. To do this, one point on the curve must be taken as a standard. Taking for this the first point on the upward slope of the curve, viz., 37·5 degrees with ·14 ampere we may proceed to find the values of the currents for the other deflections, supposing the instrument for the time being to be a tangential one. Finding the current

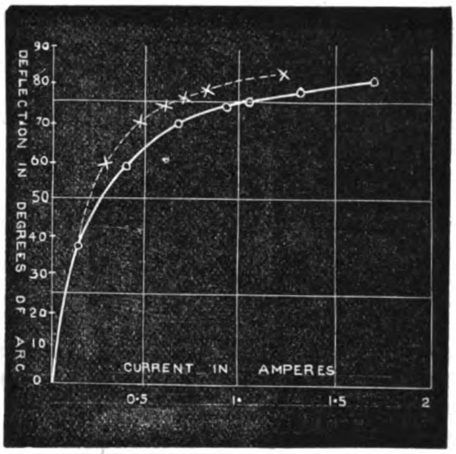


Fig. 59.

C for the next deflection of 58 degrees, we have, by simple proportion—

$$C : \cdot 14 :: \tan 58 : \tan 37 \cdot 5.$$

Hence,

$$C = \cdot 14 \times \frac{\tan 58}{\tan 37 \cdot 5},$$

$$= \cdot 14 \times \frac{1 \cdot 6}{\cdot 767} = \cdot 29 \text{ ampere.}$$

Now, 58 degrees was the deflection actually produced by ·39 ampere, but if the instrument had followed the tangent law the same deflection would have been produced by ·29 ampere. This is due to the large dimensions of the needle in comparison to the size of the coil. As the needle is deflected it moves into a weaker field owing to its length, and hence a stronger current is necessary to produce a given deflection than would be the case if the needle was of sufficiently short length to prevent its moving out of the uniform field during any part of its movement. Working out a few more points similarly to the above, keeping the first point, viz., that for the weakest current, as the standard, and plotting them on the same curve paper, the difference between the indicator in question and a true tangent instrument is made evident.

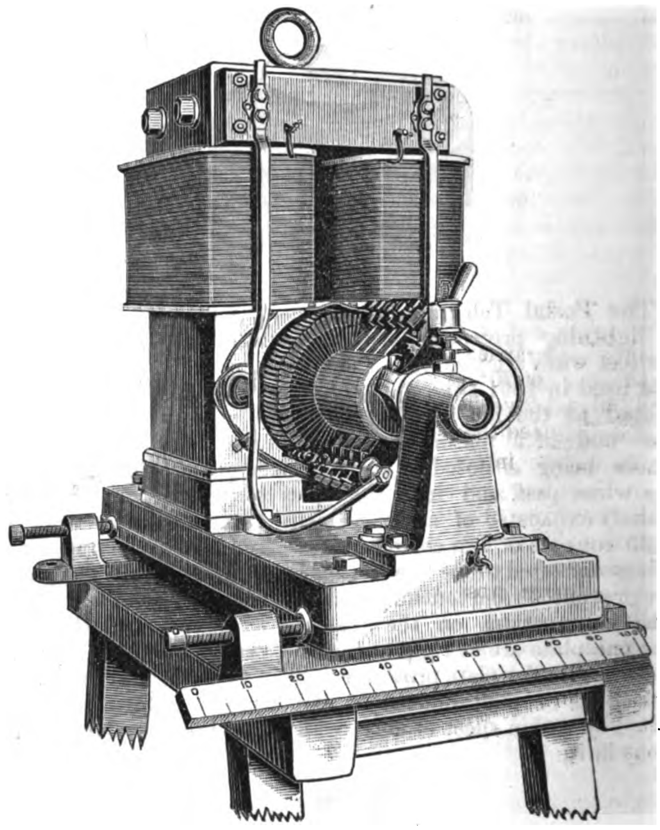
(To be continued.)

THE ARC LIGHT INSTALLATION OF THE INTERNATIONAL JUBILEE EXHIBITION OF FINE ARTS IN VIENNA.

(From a Vienna Correspondent.)

The Künstlerhaus, in which the International Jubilee Exhibition of Fine Arts is now being held, and which has been greatly enlarged and splendidly decorated for this purpose, is lighted throughout by 78 arc lamps of 10 amperes each.

Engines and Dynamos.—Two semi-fixed engines of 50 horse-power each have been hired for the time of the exhibition, and drive two large shunt-wound dynamos by means of countershafts. The one is a Marshall's compound engine working at a steam pressure of ten atmospheres, the other an engine constructed by



the Vienna States Railway Company, having two high-pressure cylinders and working at seven atmospheres. The dynamos are of the single horseshoe type with Gramme rings. The magnets are entirely made of the very best Styrian wrought iron, of a cross section of 465 by 200 millimetres; they rest with their poles on a zinc base. The armature core is built up of very thin soft iron sheets, kept together by insulated bolts, and insulated from one another by varnished paper. The windings are of rectangular sections, 12 millimetres by 5·7, every collector bar having one turn only. There are four pairs of brushes. The dynamos are capable of giving 70 volts and 430 amperes each at 500 revolutions per minute. Not the slightest spark is visible at the brushes. The electrical efficiency is 95 per cent.

Lamps.—The lamps are all in parallel, for the sake of absolute steadiness of the light, a result which has been fully attained. Each lamp is provided with an adjustable resistance in series with it. In these lamps a small single coil magnet wound with fine German silver wire, and having a resistance of 500 ohms, acts by an interrupting arrangement upon a ratchet wheel which is fixed upon a screwspindle; the latter is concealed within one of the carbon frame rods, and moves the upper carbon downwards. The feeding mechanism is exceedingly flat, the cap covering the whole not being higher than two inches. The lower

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carbon is mounted on a soft iron armature, which is attracted by an electromagnet in the main circuit to strike the arc. The carbon rods used have a diameter of ⅝in. on the positive, ½in. on the negative side. The suspension of the lamps from the ceiling is effected by means of very flexible bare copper wire ropes passing over pulleys of relatively large diameter, the bearings of which are terminals at the same time. A disc-shaped counter weight is fastened to the other two ends of the ropes, which return from the ceiling, and slides up and down, guided on the ascending parts of the ropes by means of insulating porcelain bushes.

Every lamp is provided with a plug switch, mounted on the lamp casing, a small resistance frame carrying German silver spirals and a lead cutout. These frames are placed above the glass roofs, where all leads run. Pear-shaped opal globes are used.

Leads.—The whole system of distribution is divided into two circuits, each half of the building being fed from one circuit and one dynamo. All cables, wires, and safety catches are placed above the glass roofs from which the lamps are suspended.

The mains are made of bare copper rods, twenty-three millimetres in diameter, resting upon strong porcelain insulators. The connection between these house mains and the temporary engine shed forms an interesting detail of this installation. Four heavy bare copper cables are fixed to a strong framework projecting from the roof of the Künstlerhaus; they run down in an angle of 45 degrees to the roof of the engine shed, which is standing at the opposite side of the street on the slope of the Wien river. As the copper cables are very heavy they are suspended from four steel wire ropes running above the cables, and carried by insulators as well. The dynamos create an E.M.F. of 70 volts at the terminals, 3 volts are lost in the mains and 2 volts in the distributing leads, so that 65 volts remain to feed the remotest lamp.

It may be interesting to mention that nearly 300 telephone wires run immediately above the engine shed; the Telephone Company were protesting against the erection of the large dynamos in so close proximity to their lines, but there was no other place available. The mains carrying a current of over 800 amperes cross the telephone wires at right angles, and where the cables run parallel with them they are laid bifilar to avoid induction. It was feared that the leakage lines of the dynamos would produce a noise in the telephone wires; but it seems that they are all deflected into the boilers standing close by. The best proof of the absence of induction is this, that after the installation was already working for five days, a man came from the Telephone Company to inquire when we were going to start the station.

The whole installation was carried out by the firm of Messrs. B. Egger and Co., of Vienna, under the superintendence of their first engineer, Mr. Drexler, who designed also both dynamos and lamps.

BOOKS, &c., RECEIVED.

"A Key to the Mysteries of Water, Electricity, and Heat." By William Boggett. (London: Trübner and Co. 1888.)

"Proceedings" of the Academy of Natural Science of Philadelphia. Part III. September-December, 1887.

"The Technological Quarterly." Vol. I., No. 3. Published by the Massachusetts Institute of Technology, Boston.

"A Treatise on Electricity and Magnetism." By E. Mascart and J. Joubert. Translated by E. Atkinson, Ph.D., F.C.S. Vol. II. "Method of Measurement and Application." (London: Thos. De la Rue and Co. 1888.)

"The Cornell University Register." (Ithaca, New York.)

"Price List of Incandescent Lamps of the Edison Manufacturing Company, New York."

ANSWER TO CORRESPONDENT.

Wiresman (Manchester).—*You would probably have very great difficulty in obtaining such employment as you seek, by letter, from this country; but, on the other hand, if you are a good workman, we take it that there is not the slightest doubt of your finding work on arrival in New York. We are sorry that we are not able to give you any information as to the rate of wages.*

MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-NIGHT) FRIDAY, April 6th.

Institution of Civil Engineers.

7:30 p.m. Students' Meeting. Paper to be read, "Coke Making." By Mr. G. E. J. McMurtrie, Stud. Inst.C.E.

Electro-Harmonic Society.

8 p.m. Smoking Concert at the St. James's Hall Restaurant.

MONDAY, April 9th.

Inventors' Institute.

8 p.m. Ordinary Meeting.

Society of Engineers.

7:30 p.m. Ordinary Meeting in Westminster Town Hall. Paper on "The Wimbledon Main Drainage and Sewage Disposal Works." By Mr. W. Santo Crimp, A.M.Inst.C.E., F.G.S.

Society of Arts.

8 p.m. Cantor Lecture V. Lecture on "Milk Supply and Butter and Cheese-Making" (1). By Mr. R. Bannister.

TUESDAY, April 10th.

Royal Institution.

3 p.m. Lecture, "John Ruskin" (1). By Dr. C. Waldstein, M.A., &c.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion, "Compressed Oil Gas and its Applications." By Mr. Arthur Ayres, M.Inst.C.E. Monthly ballot for new members.

Royal Victoria Hall (Waterloo Bridge-road, S.E.).

Dr. W. D. Halleburton on "Digestion, including some account of Plants that Eat Meat."

WEDNESDAY, April 11th.

Society of Arts.

8 p.m. Ordinary Meeting. "Recent Legislation concerning the Pollution of Air or Water." By Mr. Alfred Fletcher, Chief Inspector of Alkali, &c., Works. Sir Frederick Abel, C.B. D.C.L., F.R.S., will preside.

Civil and Mechanical Engineers' Society.

7 p.m. Paper on "Theatres and other Public Buildings."

THURSDAY, April 12th.

Society of Telegraph-Engineers.

8 p.m. Ordinary Meeting at the Institution of Civil Engineers. "Central Station Lighting (Transformers and Accumulators)." By Mr. R. E. Crompton, M.Inst.C.E., Member.

Royal Society.

4:30 p.m. Ordinary Meeting.

Royal Institution.

3 p.m. Lecture, "The Chemical Arts" (1). By Prof. Dewar.

FRIDAY, April 13th.

Physical Society of Glasgow University.

Paper on "Force and Energy." By Mr. W. Wallace.

Society of Arts.

8 p.m. Indian Section. "The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By Mr. W. R. Robertson, M.R.A.C., Principal, College of Agriculture, Madras. Chairman, Sir James Caird, K.C.B.

Institution of Civil Engineers.

7:30 p.m. Students' Meeting.

Royal Institution.

9 p.m. Lecture, "The Pygmy Races of Men." By Prof. Flower.

SATURDAY, April 14th.

Royal Institution.

3 p.m. Lecture, "The Later Works of Richard Wagner" (1). By Mr. C. Ambruster.

Physical Society (London).

3 p.m. "On the Measurement of the E.M.F. of Dynamos." By Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S. "On the Variation of the Coefficients of Induction." By Mr. W. E. Sumpner, B.Sc. "Some Experiments on Soap Bubbles." By Mr. C. V. Boys. "On Electromotive Forces by Contact." By Mr. G. V. Burton, B.Sc.

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THE DIRECTORY FOR 1888 IS NOW READY.

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THE AMERICAN BELL TELEPHONE SUIT.

We said when the decision in this great telephone suit was cabled from America a fortnight ago that it would be received here with general satisfaction, whatever were the grounds upon which the judgment had been given. This satisfaction will, we think, be more complete now that the full text is before us. Not only does it establish the Bell claims on what seems to us an unassailable legal footing, but it sets at rest once for all the sinister insinuations which had been imported into the case against the good faith of the man whose name will always be associated with one of the most wonderful discoveries of the present age. The Bell patents in Europe are not directly affected by the decision of the Supreme Court of the United States; but their position cannot fail to be strengthened by the evidence furnished in this case, with the result, it may be hoped, that the commercial progress of telephony will not be hampered by harassing and costly litigation. The assailants of the American Bell Telephone Company were numerous and powerful, no fewer than six companies being directly involved in the suit, those indirectly affected being, no doubt, still more numerous. It has been in progress for a considerable period of time, and sums of money have been spent on it proportionate to the magnitude of the interests at stake. Separately the cases have been tried at least once before, and some of them several times, always resulting in a triumph for the original company, except in one instance—that of the Molecular Telephone Company—and this exception has now been reversed on appeal, while in the other five cases the previous decisions have been upheld. The judgment of the Supreme Court is a complete victory for the Bell Company, and to all appearance a final one.

On the whole the chief points in dispute were not of a technical kind, but merely questions of fact, that is to say questions of priority, which were determined more by the credibility of the witnesses than by their scientific testimony. Excepting those put forward on behalf of REIS, the claims to anticipation, technically speaking, were insignificant and easily disposed of. Those preferred by Mr. DRAWBAUGH were of different character, and will be referred to later on. But as regards REIS' method, and indeed all the rest of the rival claimants, it is hard to see how BELL'S original claim, the fifth in his patent of March 7th, 1876, could be touched by them. It runs as follows:—

"The method of and apparatus for transmitting vocal or other sounds telegraphically, as herein described, by causing

electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth."

The invention as further described in the judgment "consists in the employment of a vibratory or undulatory current of electricity, in contradistinction to a merely intermittent or pulsatory current, and of a method of and apparatus for producing electrical undulations upon the line wire. A pulsatory current is described as one caused by sudden or instantaneous changes of intensity, and an electrical undulation as the result of gradual changes of intensity, exactly analogous to the changes in the density of air occasioned by simple pendulous vibrations."

Now, whatever the Reis telephone did or did not accomplish, it was certainly not by this method that he aimed at producing his results; and being the very essence of BELL'S discovery, its validity as a patent could not be upset by REIS' experiments with an entirely different method. REIS has not received full justice at the hands of the American Court, and we quite expect to see some of the *obiter dicta* of its judgment vehemently contested in this country, where the history and merits of the German inventor have been carefully studied. But as concerns this particular lawsuit, no one can seriously contest the general proposition that BELL succeeded where REIS had failed, because the former appreciated and the latter did not the true principles on which articulate telephony could be realised.

The one formidable claimant against Prof. GRAHAM BELL was Mr. DANIEL DRAWBAUGH, whose pretensions were represented in court by The People's Telephone Company. If the Drawbaugh telephone was what he and his associates represented it to be, it not only anticipated BELL'S apparatus in date but also in method. The two systems are indeed so much alike that unless by a miracle the one must have been a copy of the other. Mr. DRAWBAUGH dates his "conception and experiments" as far back as 1862, and the construction of various telephones, all on the same lines as GRAHAM BELL'S, in the years between 1866 and 1878—"perfectly adjusted and finished magneto instruments" being dated January and February, 1875; that is to say, a good twelve months prior to Bell's patent. DRAWBAUGH, however, never questioned the Bell patent till 1880 or 1881, although he went to see the Bell instruments exhibited at Philadelphia in May, 1876. Between that year and 1880 the Bell patent was being vigorously worked; hundreds of exchanges were in operation, and the telephone had evidently become a property of enormous value. Anybody, therefore, who had a telephone to patent straightway went and patented it; and there was no lack of financiers ready to take up anything that looked promising in that line of business. Mr. DRAWBAUGH'S telephones had been heard of, and he was interviewed. Some monetary transactions followed, by which one set of speculators acquired for a consideration all rights in the Drawbaugh telephones, and speedily parted with them for a much higher consideration to another and larger set of persons, who formed themselves into a company. It is no drawback to speculations of this kind that the invention about to be exploited will not work; it would not work even when brought into court in 1880; and the owners persistently refused to produce the terms of the specification alleged to have been drawn up the year previous. The great thing was to get plenty of witnesses to testify that they had heard and spoken through Mr. DRAWBAUGH'S telephonic instruments long before Mr. BELL'S were heard of. These witnesses were hunted up by the score, and their testimony has led three of the judges to dissent from the decision of the majority, on the ground that so many people could not all be mistaken. But there is no need to suppose them mistaken. Mr. DRAWBAUGH was an ingenious mechanic, and dabbled in electricity. He may, and probably did, experiment in electric telephony; but all that these people testify is to their speaking more or less inarticulately from his little shop to the cellar underneath, and to his telling them that it was done by electricity. He may have told them the truth; but for all they personally knew on this point the method he employed may have been as far removed from the Bell method as the string telephone is from the Hughes microphone.

Be this as it may, however, the failure to repeat these marvels of the shop and the cellar with appliances answering the same description in a court of law is, to our thinking, conclusive against any amount of evidence given by ignorant witnesses eight or ten years after the alleged occurrence. Coupled with the fact that DRAWBAUGH was familiar with the law of patents, being a patentee himself of at least two electrical inventions, and that he allowed BELL'S invention to go unchallenged for several years after it was fairly on the market, the above considerations entirely dispose of what little claim to originality there may have been in his "conception and experiments" between 1866 and 1876. It follows that if either of the parties copied the other's invention, the culprit was not Prof. GRAHAM BELL. In an equally conclusive manner have the graver charges against GRAHAM BELL and his solicitors been set aside relating to the alleged interpolation of his specification for the purpose of forestalling ELISHA GRAY. After a careful examination of the accusation sprung upon them at the last moment by the appellants, the judges declare that not a shadow of suspicion can rest upon any one in regard to this matter. The charge was a conjectural one at its worst, and rested solely on a discrepancy in relation to variable current in the specification, omitted in the copy furnished to BELL'S English agent. But as that document was no copy at all, and differed from the American specification in thirty other particulars, the single discrepancy fastened upon proves nothing, especially as it is an undisputed fact that BELL had this method of variable current under examination the year previous. Altogether, Mr. GRAHAM BELL comes well out of this unpleasant business, and we believe that every sincere admirer of the telephone will heartily congratulate him on the result.

ELECTRICAL STRESS.*

BY PROF. A. W. RÜCKER, M.A., F.R.S., AND MR. C. V. BOYS, A.R.S.M.

It is now some years since Dr. Kerr brought to the notice of the scientific world a most interesting method of demonstrating optically the stresses which exist in a dielectric between conductors of different potentials. His experiments have since been repeated and extended by Mr. Gordon, Quincke, Röntgen, and others. Mr. Gordon exhibited the phenomenon, using glass as the dielectric, in a lecture at the Royal Institution, and Prof. Silvanus Thompson tells us that he has shown it to his class with bisulphide of carbon. It is possible that others may have done the same; but in spite of these facts there is, I think, no doubt that the experiments are not as well known as their interest and importance demand.

Some weeks ago I had occasion to show one of them at a popular lecture, and since then Mr. Boys and I have been attempting to devise apparatus by which they might be readily exhibited to an audience. In the course of that time we have conversed on the subject with several well-known electricians, and found that many of them had not seen the simplest of the

* Paper read at the Society of Telegraph-Engineers and Electricians on Thursday, March 22nd.

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phenomena which I hope presently to exhibit to you. I shall therefore offer no apology for bringing before the Society a subject the theoretical explanation of which is for the most part well understood.

There is, however, another point of view, namely, that of the teacher, from which I think lecture experiments on the optical demonstration of electrical stress are valuable. It is very desirable that students should from the first be impressed with the fact that the dielectric plays a part in electrical phenomena as important as that of conductors. In no way, perhaps, can this lesson be more clearly taught than by the glow, which, when the dielectric is investigated by polarised light, indicates the stresses to which it is subjected.

I will, however, begin my lecture by exhibiting an experiment of another kind, which illustrates the same fact. It is practically a reproduction of the method by which measurements of the specific inductive capacities of various substances were at first attempted.

Three insulated metal plates A, B, C are arranged parallel to each other. The two outer ones, B and C, are in connection with the opposite pairs of quadrants of a quadrant electrometer. They can be put to earth by connecting the insulated mercury cups in which the ends of the connecting wires dip with a third cup which is not insulated. The middle plate is then charged without any effect being produced on the electrometer. On breaking the earth connections and pushing a plate of paraffin attached to a long ebonite arm along a groove which directs it between the middle and one of the outer plates a deflection of the electrometer needle is obtained so large as to fling the index spot of light completely off the scale. The

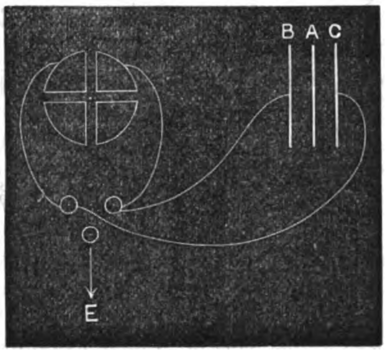

Fig. 1.

movement is in the same direction as that which would have been produced by reducing the distance between the two plates, and thus the experiment proves that induction takes place through paraffin more readily than through air. To meet the objection that the effect is due to the surface of the paraffin being moist or dusty, and that from these or from some other causes it has become a conductor, I touch it, and you observe that the deflection is unaltered. If, however, I repeat the experiment, enclosing the paraffin in a metal case, although the first effect is similar to that previously obtained, yet when I touch the metal the direction of the deflection is, as we should expect, suddenly reversed. [Experiment performed.]

Having thus illustrated the fact that the dielectric plays a part in the phenomena of induction, I may remind you of Maxwell's celebrated theory that it is, in such cases, in a state of stress. A tension exists along the lines of force, whilst a pressure is exerted in all directions at right angles to them. If this is so we should expect that a structure equivalent to that of a crystal in its effects on polarised light would be produced. The properties of the substance would be different in directions parallel and perpendicular to the lines of force. The tension and the pressure would affect them oppositely.

This fact Dr. Kerr utilised. Assume that the lines of force are horizontal, and that plane-polarised light, the vibrations of which take place in a direction inclined at 45° to the horizontal, enters the stressed dielectric. Let matters be further simplified by supposing that the ray of incident light is perpendicular to the lines of force. Under these circumstances the single ray may be regarded as broken up into two in which the vibrations will take place along and perpendicular to the lines of force respectively. These rays will travel with different speeds.

On emerging from the dielectric they may be regarded as recombining; but since one has travelled faster than the other, they do not in general recombine to produce plane-polarised light. If, then, before the electrical stress was produced, a Nicol's prism had been arranged to cut off the plane-polarised light, the production of the stress would modify the light so as to make it possible for a portion of it to pass through the prism.

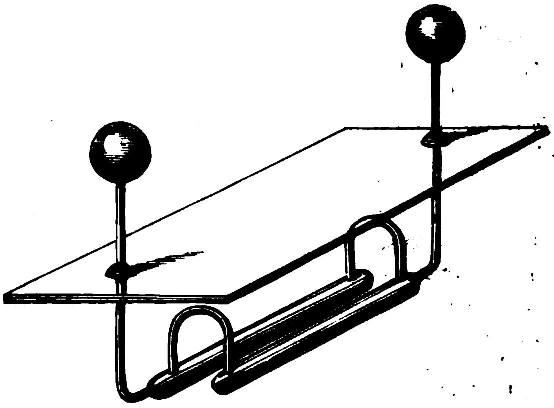

Fig. 1a.

A similar effect may readily be produced without the aid of electricity. I throw upon the screen the image of a small bar of glass. The light which falls upon it is plane polarised, and now a Nicol's prism is turned so as to cut it off. The field becomes dark. If, however, the glass be bent the concave side is compressed, the convex half is extended. The compression and extension take place in directions parallel to the length of the bar. Its dimensions perpendicular to its length are practically unaltered. Thus, its properties in directions parallel and perpendicular to its length are different. The incident light is broken up into two rays which travel with different velocities. These on recombining do not produce plane-polarised light. Some of the modified light can traverse the second Nicol's prism, and as the bar is bent you see it brightly illuminated on the screen. Regions of compression and extension are separated by a black line. In the parts which it traverses no alteration is produced by bending; the light emerges—as it entered—plane polarised, and fails to penetrate the second prism.

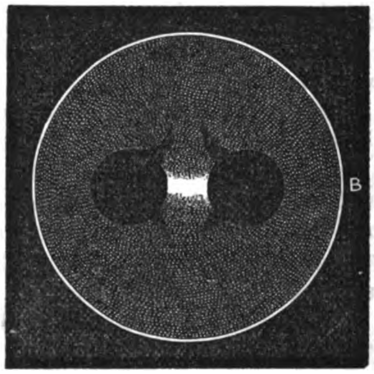

Fig. 1b.

I will now show you Dr. Kerr's fundamental experiment, which proves that there is a close similarity between the behaviour of the glass and that of a dielectric subjected to electrical stress. Dr. Kerr's observations were made by passing a beam of plane-polarised light between two metallic spheres immersed in carbon bisulphide. The light was extinguished by a Nicol's prism, but was restored when the spheres were oppositely electrified. It might, and probably would be possible with great care and by using a liquid quite

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free from dust, to show the effect to an audience. It is, however, much better to use the apparatus shown in Fig. 1*a*. For spheres we employ two cylinders about 100 mm. in length. These are placed in a cell with glass ends, so that their axes are parallel and are perpendicular to the screen. Plane-polarised light is passed between them, and when an image is formed only the ends of the cylinders are seen, so that they present exactly the same appearance as two spheres would do. The light is extinguished by turning a Nicol's prism, but when an electrical machine, with which the cylinders are connected, is worked it is brightly restored (Fig. 1*b*). [Experiment.] For purposes of exhibition we obtain a great advantage by causing the light to traverse three or four inches of stressed liquid instead of a short distance in the neighbourhood of two spheres. To prevent the cylinders from being drawn together by the attraction which exists between them when they are oppositely electrified they are held apart by thin curved rods of glass, terminating in brass tubes which are soldered to the cylinders.

These experiments are attended with a certain risk, against which it is well to take precautions. The bisulphide is easily inflammable, and may catch fire if a spark passes in the neighbourhood of the cell. It is therefore necessary that the cells should not leak. They are made of wood with glass ends, and the joints are made tight with shellac varnish. The wires which support the conductors are passed through plates of glass, which cover the cell and thus prevent the free escape of the vapour. To make assurance doubly sure the cells are placed in a larger cell, so that if, as is sometimes the case, the glass ends are cracked by the passage of a spark through the liquid, the carbon bisulphide flows into the larger cell instead of falling on to the table or floor. This larger cell is itself placed in a wooden tray, the edges of which are turned up, and we have ready a tin plate extinguisher, which can be put over the whole apparatus in case the vapour should accidentally ignite.

The last experiment illustrates the fact that the dielectric between two oppositely electrified bodies is in a state of stress. An arrangement may easily be made to prove to a class that the tendency to separate observed in two similarly electrified bodies may be regarded as due to an attraction between each of them and surrounding bodies rather than to a direct mutual repulsion. Two cylinders arranged as before are placed between two vertical plates, which are parallel to the axes of the cylinders. Both cylinders and plates are immersed in bisulphide. The plates are connected with one terminal of the machine, the cylinders with the other. On electrification, two bright patches appear on the screen between each cylinder and the nearest plate. Taken in conjunction with the last experiment this illustrates the fact that there is an attraction between the cylinders and plates, and that the medium between the cylinders is not subjected to any considerable stress.

The next experiment introduces us to a point of some considerable theoretical interest. Glass touched by a hot poker becomes doubly refracting, because the temperature varies from point to point round the spot at which the heat is applied, but if it were uniformly warmed it would be singly refracting. There is, then, a difference between a crystal and a piece of unequally heated glass. In the former the molecules around any given point are differently arranged in different directions, but the constitution of the crystal is the same throughout. In the latter the temperature, and with it the arrangement of the molecules, varies from point to point. Now Prof. Quincke has shown that the volume of a dielectric alters when it is subjected to electrical stress, and the question arises whether the double refraction is produced, as it were, indirectly by this change of volume, or directly by what may be regarded as a crystalline arrangement of the molecules.

If the former view be correct, then as glass is doubly refracting only when it is unequally heated, a dielectric will exhibit the same property only when it is subjected to an electrical stress which varies from point to point. In the latter case double refraction will be produced by a uniform as well as by a variable stress.

Two parallel metal plates are now placed in the bisulphide; the light which passes between them is extinguished by the analysing Nicol. The plates are connected with the opposite terminals of the machine, and as soon as they are electrified the space between them is illuminated [Experiment.] (Fig. 2*b*.) If the bar of glass is held in front of the cell and bent, the black central line is broken. Where it crosses the stressed dielectric it is shifted towards the side on which the glass is compressed. Thus, when glass is compressed in a direction parallel to that in which the lines of force traverse the bisulphide, the double refraction produced on the liquid tends to neutralize that to which the compression gives rise in the glass (Fig. 2*c*).

Returning, however, to the question we were discussing, as to whether double refraction is produced in the bisulphide only where the stress is not uniform, it is remarkable that if plane-polarised light is passed through a plate of glass, the opposite sides of which are coated with oppositely electrified conductors, and which is placed between crossed Nicols, no re-illumination is produced by the electrification. This makes it important that the phenomenon should be more fully studied, and I will next show you an experiment which is conclusive as to the nature of the action in the liquid. The metal plates are replaced by two others similar to them in all respects, with the exception that in the upper parts of each of the plates

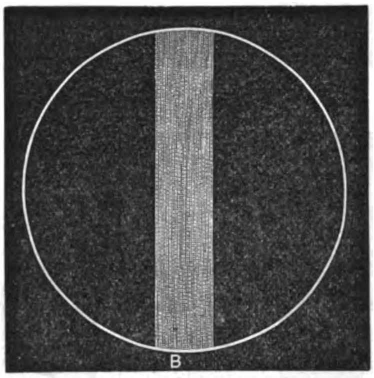

Fig 2b

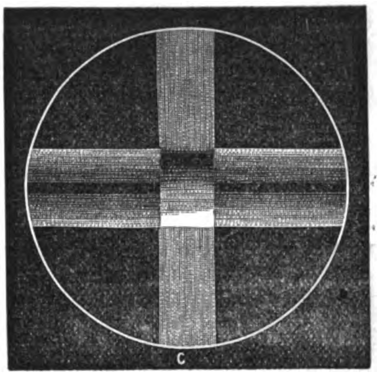

Fig. 2c.

two windows are cut which are exactly opposite to each other. The light, therefore, which traverses the space between the upper parts of the plates passes six edges, that which travels between the lower parts is brought near two edges only, but penetrates a far greater thickness of uniformly stressed liquid. If the double refraction is due to a quasi-crystalline constitution induced in regions of uniform stress, the light, when restored by electrification, will be bright in that part of the image which corresponds to the lower parts of the plates. If non-uniformity of stress is essential it will be brightest where it has passed near the greatest number of edges. [Experiment.] There is no doubt as to the result the uniformly stressed region is much the brighter. In glass, on the other hand, it appears that a stress which varies from one point to another is necessary to produce double refraction.

The next experiment is devised chiefly for use in an elementary lecture. The metal plates are bent twice at right angles, so that on the screen they represent the inner and outer coatings of a Leyden jar. To make the illusion a little more complete a

knob is attached to one of the wires (Fig. 3*a*). When the conductors are oppositely electrified a glow appears between them, which proves to the student that a stress is produced in the dielectric (Fig. 3*b*). At the two corners black brushes are seen, which are parallel to the principal planes of the two Nicols. [Experiment.] If before the plates are electrified the bar of glass be intro-

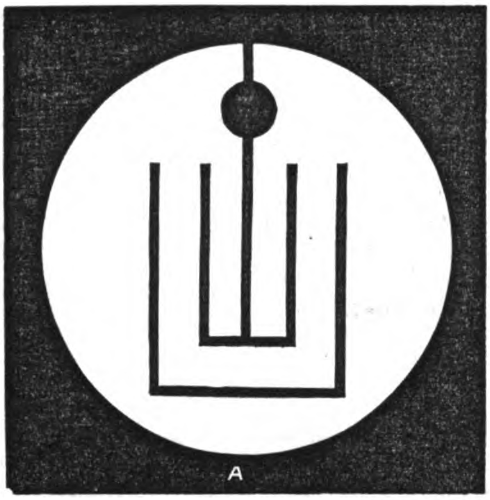

FIG. 3A.

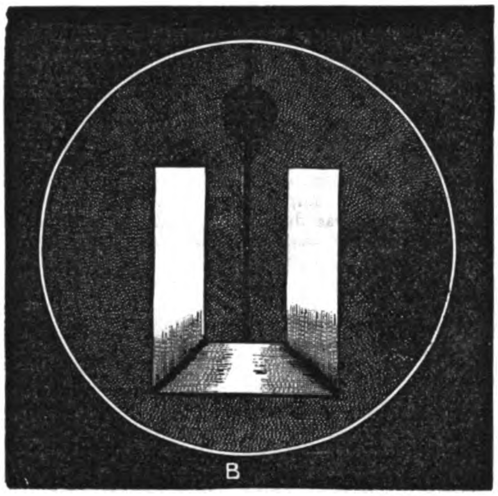

FIG. 3B.

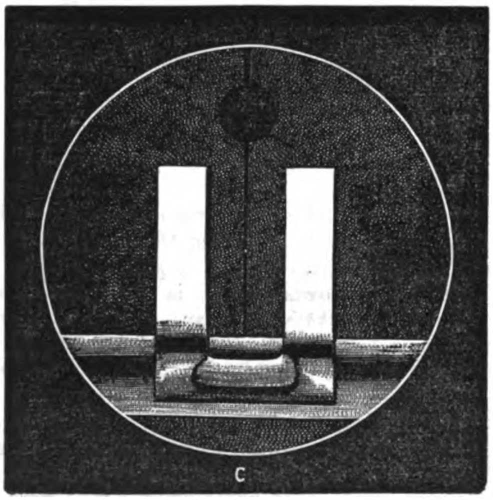

FIG. 3C.

duced and bent so that the black line which appears in its centre coincides with the bottom of the inner conductor, it will be observed that on electrification the line breaks into three parts. Between the vertical sides of the Leyden jar the lines of force are horizontal, and the bar is so bent that, as in a previous experiment, the black band is shifted upwards where it crosses them. Between the bottoms of the inner and outer coatings the lines of force are vertical, and the action will be reversed. The direction of relative compression and that of the vibrations which travel fastest in the stressed liquid, are both turned through a right angle, and here the black band travels downwards towards the outer coating. [Experiment.] (Fig. 3*c*.)

I will next use as conductors two cylinders placed one inside the other, with their axes coincident. On the screen they look like two concentric circles. When the light is extinguished and restored by electrification, the black cross so familiar in experiments on crystals is immediately visible. [Experiment.] (Fig. 4*b*.)

So far I have dealt only with cases in which the light which reappears on the screen is white; we will now modify the arrangements so as to produce colour effects.

When a very thin crystalline plate is interposed between crossed Nicols the light which traverses the second Nicol is white. You will remember that the restoration of the illumination depends upon the fact that the velocity with which the light travels varies with the direction of vibration. In the case of the dielectric vibrations are propagated at different rates, according as they are parallel or perpendicular to the lines of force.

This difference of speed is, however, itself different for lights of different colours, and if the thickness of the crystalline plate is increased, very beautiful colour phenomena are developed. The proportions of the different colours which traverse the second Nicol are widely varied. The emergent waves do not recombine to produce white light, and the tint actually observed changes with the thickness of the crystalline plate.

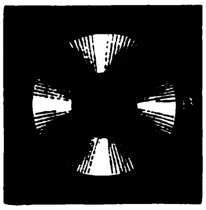

FIG. 4B.

The images of two wedge-shaped pieces of quartz are now thrown upon the screen, and you see that the colour varies from white at the thinnest ends, through orange, red, purple, and blue to green. [Experiment.] Curiously enough, the range of tints which these particular crystals exhibit is almost exactly the same as that which I hope presently to produce by electrification, though in the case of quartz the phenomenon is due to causes different from these I am now discussing.

In the case of a dielectric colours will be exhibited if we increase the stress sufficiently, even if the length of the liquid column traversed by the light is not largely augmented. I will therefore use a "Franklin's pane" in which the two plates are nearer together than in the previous experiment. The risk of discharge from the one plate to the other is now greater. The plates are therefore made thicker and the edges are carefully rounded. [Experiment.] As the machine is worked white light first appears. Now it begins to turn orange, which changes into red and purple. [On repeating the experiment the insulation was maintained until the green of the second order appeared on the screen.] The green of the second order is the tint which Dr. Kerr succeeded in reaching. Yesterday, when trying the experiment at South Kensington, we obtained the red of the second order, and have thus, I believe, carried the observations to a point on the scale of colours which had not been previously attained in this way. I will now repeat the experiment, placing a direct vision prism in front of the stressed liquid. When the plates are charged a spectrum appears on the screen. [Experiment.] A black interference band now enters from the violet. As the difference of potential increases it blots out the green and invades the red at the moment that a spark passes, and the phenomenon disappears.

The next experiment is a modification of the last. One of the two conductors is plane, the other is slightly curved. On

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electrification the colours appear in the middle, where the conductors are nearest and the stress is the greatest. From this point they travel outwards in both directions, each tint, as the charge increases, being succeeded in regular order by those which follow it on Newton's scale. [In this experiment the colours varied from the green of the second order in the centre to the white of the first order near the edges of the conductors.]

I will now exhibit another modification of the experiments, by which no new point of theoretical interest is introduced, but which is very beautiful, and presents some practical advantages.

If a plate of selenite be introduced between the crossed Nicols the light is restored. The crystal we use is of such a thickness that the field is a rich blue. You can thus see the image of the apparatus before electrification. We will use first the two parallel metal plates. When they are electrified the retardation of one ray in the crystal will be augmented or decreased according to the direction of the lines of force, and the colour will change. [Experiment.] You now see that while the outer parts of the field remain blue, the central parts between the two metal plates alter to a purple red.

If we now use the concentric cylinders, the black cross appears as before, but the two pairs of quadrants become differently coloured. [Experiment.] The same phenomenon can be shown still more brightly in another way. Replacing the condenser by the Leyden jar apparatus, the blue changes in the vertical spaces to red, in the horizontal space to a greenish yellow. [Experiment.] The lines of force run in different directions, and the retardation, which is increased in the one case, is diminished in the other.

This concludes the experiments which I proposed to show you. As I have already remarked they have no novel theoretical interest; I venture, however, to believe that we have effected some improvements in the method of exhibiting them in public, and I hope that on that account a grave Society like that which I have the honour of addressing will forgive us for introducing to its notice phenomena which, if not new in principle, are at all events beautiful.

DISCUSSION.

After some complimentary remarks from Prof. FOSTER and Prof. ADAMS,

Mr. GORDON said that as these experiments illustrated the theories of Clerk Maxwell, it might not be out of place if he reminded the Society of a passage in a very little-known book of Clerk Maxwell, which was a little elementary text-book on electricity, published by the Christian Knowledge Society. In that book Clerk Maxwell had a speculation in which he pointed out that objects are seen by the sense of sight owing to its being able to detect differences in the amount of illumination of different bodies. We know that different bodies are of different potentials and different electrifications, and he speculated on what could be seen if we had a sense that would enable us to detect differences of electric potential as the eye does detect differences of optical potential—optical brightness. He thought Prof. Rücker's experiments had gone very far towards putting that sense at their disposal. It enabled them to see the differences of electrical potential, the possibility of seeing which in different bodies was predicted by Clerk Maxwell about fifteen years ago. It was very curious to see how every experiment seemed to confirm the ideas which the physical insight of Faraday, supplemented afterwards by the mathematical insight and theory of Clerk Maxwell, predicted. They all remembered Clerk Maxwell's beautiful conception that light itself was an electromagnetic disturbance. Clerk Maxwell, as they might remember, pointed out that the phenomena of electric induction might be explained by the supposition of an ether which should have certain properties and which would transmit the waves of electromagnetic induction. Maxwell then pointed out that by experiments on the ratio of electrostatic to electromagnetic units, and on specific inductive capacity, that the velocity of electromagnetic induction not only in air *in vacuo*, but in a great many other bodies could be determined, and he pointed out that if it should be shown hereafter that those velocities were the same, not only in air *in vacuo* but in other bodies, it would be a great confirmation of the theory that light itself is an electromagnetic disturbance. He remembered Clerk Maxwell saying to him, when he had the honour of being his pupil (he did not think it was in Clerk Maxwell's book), that it would be absurd to consider the whole of every part of space as filled with two ethers, which were exactly alike in their most important properties—exactly alike in every property that we could measure or discuss, and yet should be different and not the same. Maxwell's theory was, that the same ether transmitted the waves of electricity and the waves of light. Since then a great many experiments had been made. He had himself made a certain number of experiments on various substances, and Dr. Hopkinson had also made a great many. He thought they all found certain very curious resemblances and certain discrepancies. The electromagnetic and the electrostatic units were found to be practically identically equal to that of light; but whenever they came to gross substances, like paraffin and other solid substances, they had difficulties. Sometimes they found great resemblance, but sometimes great discrepancies. Directly they came to experiments on gas (he remembered that Prof. Ayrton and Prof. Perry published first experiments on gas) there was found, what might have been expected, that the disturbing forces acting in grosser substances were eliminated, and the velocities of light and electromagnetic induction were almost identically equal through the whole long series of gases. It seemed to him that evidence from gases, where there was not likely to be much internal friction or disturbing causes, was much more likely to be trustworthy than any evidence on the other side from solid bodies in which a number of extraneous conditions would appear. There was one other remark he would make. Prof. Rücker had very kindly alluded to some experiments he himself had made on the residual charge of a Leyden jar, which he showed at the Royal Institution. Although he had the honour of showing the experiments, they were made by Dr. Hopkinson, and communicated by that gentleman to himself, and shown by him at the Royal Institution soon afterwards.

Prof. PERRY thought that in the first experiment it was possible that the result was in reality due to a layer of moisture on the surface of the paraffin wax.

Prof. AYRTON believed that Faraday himself had tried for a very long while to show the stress in glass when it was electrified. He wished to ask Prof. Rücker whether, having made experiments in the subject, he had made any calculations as to the effect obtained compared with the mere electrostatic attraction due to the pressure of the two electrified coatings of the Leyden jar? Why was it they got so little effect with glass, which was supposed to be under electrical strain? He understood from Dr. Lodge that, as a matter of fact, the sort of effect they got with glass could really all be explained by the mere electrostatic attraction of the two electrified coatings squeezing the glass. With a very little pressure on a piece of glass they could produce quite as much effect, when tested by polarised light, as they could by producing very large differences of potentials in the two sides. If they had only experiments on glass, they would be inclined to think that the whole thing was mere pressure, and that there was not proved to be any electrical strain inside the glass at all. He did not mean to say for a moment that therefore one should conclude there was no electrical strain inside the glass, but merely that the experiment with polarised light did not prove its existence. When they came to the very beautiful effects that had been obtained that evening with carbon bi-sulphide, they could not apply the same explanation that the effect was due to mere electrostatic pressure. He would like to echo Dr. Hopkinson's question—Why it was that Faraday failed in glass? Why was it so extremely difficult when polarised light was seen through glass which was under electrical stress to get any effect under the polarised light? Dr. Lodge, he understood, regarded it as a kind of residual phenomenon. With regard to the action of the paraffin wax, he believed that the experiment of jacketing the slab of wax with metal was directed against himself personally, and therefore he would mention that he held his judgment in suspense. He was inclined to think that what he had seen that evening did not prove that they could with certainty measure the specific inductive capacity of paraffin wax in the way shown. He should be rather inclined to say that it proved that there were layers of moisture on the paraffin wax, because, as Prof. Perry remarked, they got about the same effect when they put a metallic coating on both sides of the paraffin wax as when they did not have paraffin wax at all. The conclusion to come to, therefore, was that there was some coating of moisture existing on the two sides of the paraffin wax. Why this coating of moisture was not entirely electrically discharged on touching it was perhaps because the paraffin wax was itself a good insulator and the film of moisture coating it was but an imperfect conductor, whereas the metallic coating could be discharged at once on touching it. The action of the moisture on the wax could, he thought, be represented by having the paraffin wax very clean and dry, and then dusting it *lightly* over with some fine metallic powder. Whether or not moisture played any important part in the experiment they had seen, he thought that too much care could not be exercised in eliminating the creeping effect that moisture produced in statical electrical experiments. The previous speakers had all spoken of the great pleasure they had derived from the lecture. The feeling was warmly shared by himself, for it was one thing merely to know or to teach, as they had been accustomed to do, that the electrical action of a Leyden jar took place in the dielectric and not in the coatings, and another thing to see this very action in the dielectric evidenced on the screen.

After a few words from Dr. JOHN HOPKINSON,

Prof. SILVANUS THOMPSON remarked that he thought they had reason to congratulate themselves on being Britons, as Continental text-books were still written under the shadow of the great Continental mathematicians, who, setting out from the law of inverse squares, had only realised action at a distance. From this, however, Faraday had delivered us, in proving the existence of stresses in the dielectric. Whilst Maxwell had speculated as to what we should see if endowed with an "electric sight," Faraday had in addition speculated as to what we should see with a magnetic sight, and in this connection had made his well-known experiments on the action of heavy glass, under the influence of a powerful magnetic field, on polarised light.

Prof. RUCKER, in reply, said that Prof. Ayrton's explanation of the experiment with the slab of paraffin involved a change in its properties during the experiment. If its surface was a conductor it must be a very

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good conductor, as the movement of the electrometer was instantaneous and very considerable. It ought, therefore, when touched to behave like a good conductor; but the experiment proved, on the contrary, that if there was free electricity on the surface it could not be discharged by touching the paraffin. He had not repeated the experiments with glass, and it was much to be desired that the cause of the difference in the behaviour of glass and liquids should be more fully investigated.

Mr. BOYS said that if the electrostatic attraction referred to by Prof. Ayrton were really sufficient to produce in glass an effect as great as that due to electrical stress, then it was just possible that this might account for the absence of any luminous effect when glass was subject to a uniform electrical stress. In some materials the electrical stress along the lines of force was optically equivalent to a mechanical compression, and in some to a mechanical extension. If it should happen that in glass it should be equivalent to a mechanical extension, and should be equal optically to the compression caused by the electrostatic attraction, then since the two effects would be always equal whatever the difference of potential, one would neutralise the other, and the field would remain dark, as in practice is found to be the case.

UTILISATION OF ELECTRICITY IN SOUTH WALES MINING OPERATIONS.

ELECTRIC SHOT-FIRING, LIGHTING, AND SIGNALLING.*

The leading colliery owners of South Wales are discovering the advantages of the use of electricity in mining operations, and visits paid to some of the pits in the great coalfield of the Rhondda Valley have enabled me to witness the splendid results obtained in utilising the electric current for blasting, or "shot-firing," for lighting above and below ground, and for signalling.

I visited the Standard Colliery, Ynyshir, a few days ago, and, by the permission of the manager, was conducted over the entire works, above and below ground, and had the pleasure of practically testing the blasting apparatus by firing six shots myself.

First of all, let us glance at the electric appliances on the surface. There is a 100-volt dynamo, supplied by the Gülcher Electric Light and Power Company, with an arrangement for 100 lights of 16 candle-power, distributed over various parts of the colliery. The dynamo is 10 horse-power, worked by a Marshall steam engine of 6 horse-power, and it was explained to me that the management found it best to have the electric power of the machine larger than the mechanical power of the engine. In the colliery yard is a 5-arc lamp, while in the engine houses, stables, at the pit top, and in the most useful places below are incandescent lamps supposed to burn for 1,000 hours, but which have already been in use for thirteen months at the rate of 144 hours per week underground, and about half that time on the surface, and still they show no signs of wearing out. From the dynamo to the pit top, and thence down the shaft, the wires are fixed, and so arranged that the same lines of positive and negative are used for lighting, signalling and blasting; consequently, at a comparative trifling cost, the greatest efficiency is attained in all three departments of pit work. The value of the signalling apparatus may be imagined when it is stated that owing to its rapid action the management has been able to increase the output of coal by no less than fifty tons per day.

Accompanied by Mr. J. Thomas, overman, and others, I descended the shaft, which is 375 yards deep, and reaches the 2ft. 9in. seam. From this to the 4ft. seam, about 20 yards deeper, we proceeded along a drift, or dip, and as this is the vein worked at the colliery—from which there is an output of 700 tons a day—the main portion of the blasting was done here. It being Saturday, the miners had left working, and the officials primed the shot-holes, which had been bored in readiness. In the "East Dip" there were five holes, which were primed with clay. The wire was inserted, the connection with the dynamo having previously been taken off, and the shots were declared to be ready. Only a single wire was used, the "return" being made by the earth. We next went to the return side of the colliery, where two more shot holes were primed—and it may not be amiss here to remark that while the entire company carried safety lamps, my friend and I were favoured with portable electric lamps, one of Pitkin's and one of the Swan Company's. The latter gave a wider radius of light, while the former threw a stronger illumination directly in front—no doubt each having its relative merits. While we were inspecting the stables, engine planes, &c., which were brilliantly lighted, a messenger was sent to the surface to direct the man in the engine-house to stop the electric machinery, and when the current ceased, the switches were turned on, so that immediately the force of the current should be put on again the blasting would take place. The fixed lights at the pit bottom were extinguished, of course, by the stoppage of the engine, and the old system of signalling had to be resorted to when we wanted to ascend the shaft—viz., the ponderous hammer. However, the cage starts, and a little more than half a minute later we are at the pit top. The Marshall engine is once more started, and I place my hand upon a small lever, the moving of which sends the electric current along the wires to the shot-holes, about 900 yards away; and almost at the same instant the blasting takes place. There is not a soul in the pit. In this fact we see one of the advantages of blasting by electricity. It can be carried on from the surface to an unlimited extent, and if any of the shots happen not to go off you are, the moment the wires are disconnected, perfectly safe in going to examine the hole—a very different state of things from that of the old system of blasting.

We again descended to see the result, and, on getting to the bottom, switched off the electric current from the wires leading to the East Dip. The five holes in the East Dip were found to have been successfully fired, the hard stone top having been brought down as effectively as desired. In the "return" the two shots had failed, owing to either a bad cap or a faulty connection, and arrangements were made for properly blasting them. Such an arrangement hastens very materially the speed at which work can be carried on. The workmen like it because it is much safer than the old plan of firing by fuse, and the employers favour it because it is simple, economical, effective, and rapid, as well as, in the opinion of the management, calculated to reduce to a minimum the risk attendant upon blasting in mines.

Special interest attaches to the system—for we can no longer describe it as a mere experiment—when it is remembered that this was the colliery selected by the late Mr. T. E. Wales, Government Inspector of Mines, to become the subject of the "test case" directed to be taken by the Home Secretary, in order to set at rest a dispute between him and the South Wales Miners and mine owners as to the right of blasting without withdrawing the workmen. That, of course, was under the old Act, now superseded by the new Mines Regulation Act.

* From a Correspondent in the *Iron and Coal Trades Review*.

COMPARATIVE VALUE OF CONTINUOUS AND ALTERNATING CURRENT SYSTEMS FOR THE COMMERCIAL DISTRIBUTION OF ELECTRICITY.*

BY H. WARD LEONARD.

There exists to-day a great deal of uncertainty in the minds of many persons interested in the distribution of electric energy as to the comparative value of the continuous-current three-wire system and the alternating-current converter system; and as the published statements relative to these two systems have apparently greatly exaggerated certain advantages and disadvantages of the one system and the other, I will endeavour to institute what I consider as fair a comparison as possible between the two systems, using the best data at my command, and giving due weight to the several factors necessary in a general system for the distribution of electric energy on a commercial scale.

In considering the comparative value of these two systems, let us compare them with each other upon the following points, which I consider the vital ones in a general supply system of electric energy:—

First.—First cost.
Secondly.—Economy, efficiency and depreciation.
Thirdly.—Reliability.
Fourthly.—Variety and value of the possible sources of revenue.
Fifthly.—Safety to life.
Sixthly.—Effects upon existing property.

First: Cost and Economy.—This is a feature which is subject to variations which are not similar in the two systems, and it may be well to give some general explanations of the cause. In a three-wire system the principal items of cost are the generators, main conductors, and inside wiring. In the alternating system the main items of cost are generators, primary circuit, converters and secondary circuit.

The cost of the generators is, as far as I am able to judge by inspection and comparison of prices, about the same. At any rate, any possible difference in this respect must necessarily be but slight in its influence on the total cost of which it becomes a very small factor. We therefore come to a comparison between the cost of the feeders, mains and inside wiring of the three-wire, and the cost of the mains, converters, and inside wiring of the alternating system.

The cost of the conductors transmitting a given amount of energy at given loss for a given distance varies, generally speaking, inversely as the square of the initial electromotive force employed. For instance, if the E.M.F. of one system be 1,000 volts, and that of another be 110 volts, the cost of conductors for the latter under similar conditions would be to the cost of the former as 1,000,000 ($1,000^2$) : 12,100 (110^2), *i.e.*, as 82 : 1.

* Read before the Chicago Electric Club, March 5, 1888. The first of a series of Papers upon the subject, "The Continuous Current *v.* The Alternating Current," before the club.

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In the three-wire system double the E.M.F. of the lamps is used, and the practical effect is the same as if the lamps were operated in series as far as the two outside conductors are concerned.

In order to secure complete independence of each individual lamp, a third wire, called the neutral wire, is run. This wire has a potential midway between those of the two outside wires, and in practice only carries the amount of current represented by the difference between the number of lamps burning on the two sides of the system.

Since the three-wire system has practically two lamps in series, and since the resistance of the two lamps in series is four times that of two lamps in multiple arc, it follows that, with the same number of lamps, the resistance of the lamp circuit is in the three-wire system four times that of the two-wire system. Therefore, for the same percentage of loss due to the resistance of the conductors, the size of the wires for the three-wire system need be only 25 per cent. the size and cost of those for a two-wire system. The neutral wire, if it be of the same size as the outside wires, would add one-half more to the cost, making the total cost, instead of 25 per cent., 37½ per cent. of the two-wire system. In practice the size of the neutral wire is less than that of the outside wires in the feeders, and the cost is thereby reduced so that in practice the cost of conductors is 33 per cent., or one-third of the cost of the wo-wire system.

We saw that the cost of a conductor for a 110-volt two-wire system and a 1,000-volt converter system was as 82 is to 1. It is now evident that by using the three-wire system this ratio becomes as 27·5 is to 1.

The three-wire system is not, of course, limited to the electromotive force quoted. The Edison Company operate dynamos of 1,200 volts in a three-wire system for their municipal system. The standard three-wire system of to-day is limited by the difficulty in manufacturing lamps of much higher voltage than 110. When the time comes, and it seems near at hand, that lamps can be had of double the voltage of those, the cost of conductors of the three-wire system will be one-fourth of what it is to-day ; or, in other words, existing conductors will be able to supply four times as many lamps as at present, and at the same loss ; also, an increase in the economy of the incandescent lamps would reduce the cost of conductors proportionately, and we can, of course, expect to see very great improvement in this direction.

It is evident, therefore, that the cost of conductors in the three-wire system will be reduced by inevitable improvements in the lamp itself to but a small fraction of its present cost.

Now let us look at the alternating system under similar conditions. Outside of the generator the converter is the principal item of cost, the cost of conductors being slight in comparison, as we will see later. An increase in the voltage of the lamps would be of no benefit whatever, and an increase in the economy of the lamps would result in a proportional reduction in the cost per lamp. Let us suppose that the voltage of existing lamps be doubled, and the economy increased 25 per cent., both of which results are likely to be seen in a very few years, if not sooner. The cost of conductors for the three-wire system would be reduced 80 per cent. and the cost of converters would be reduced 20 per cent., or, in other words, existing three-wire conductors would be able to supply five times as many lamps as at present, an increase in capacity of 400 per cent., and existing converters would be able to supply 25 per cent. more than at present.

So much for the probable reduction in first cost consequent upon improvements in the economy of the lamp itself, the only place in any incandescent system where much increase in economy can be expected, as existing devices are all claimed to, and most of them do, show an individual efficiency of 90 per cent. and upwards.

Let us now examine the comparative cost as these systems exist to-day. In order to do this it becomes necessary to determine the cost of conductors under the varying conditions met with in practice ; and this can be conveniently done by applying the following formula deduced by the writer, the accuracy of which has been tested by practical use for about two years :—

Let T C P be the total candle-power.

Let D be the mean distance current travels (one way).

Let L equal price per pound of copper (in cents).

Let V be volts lost in conductors (both ways).

Let E be E.M.F. of lamps.

Let C H P be candles per electrical horse-power.

Then
$$\$ = \frac{T\,C\,P \times D^2 \times L}{V \times E \times C\,H\,P \times 1{,}000}.$$

For the three-wire system one-third of this.

Before proceeding to apply the formula let us clearly understand that with a continuous current the loss in conductors is exactly proportional to the amount of energy they transmit ; *i.e.*, any variation in the load causes a proportional variation in the loss in conductors.

With the alternating current this is not the case, the decrease in the energy transmitted resulting in but a slight decrease in the current. Thus, with a continuous current the loss in conductors under conditions of one-quarter load is one-quarter what it is at full load, but with the alternating current the loss in conductors at one-quarter load is probably 75 per cent. of what it is at full load. However, as this conclusion is based mainly on theoretical grounds, I will, in comparison, grant that the alternating current will be as efficient in this respect as the continuous current.

Careful examinations of the load diagrams of some 50 Edison central stations show that throughout the run the average load is from 33 to 40 per cent. of the maximum load ; *i.e.*, if the loss in conductors is 10 per cent. when the full load is on, the average loss throughout the whole time the plant is supplying light is but 4 per cent.

Table I shows the maximum loss expressed in volts, the corresponding maximum per cent. of loss, the corresponding average per cent. of loss, and consequently the average efficiency of the system of conductors.

TABLE I.

System.	Three-wire System.			1,000-Volt Alternating-Current System.		
Maximum loss in volts	12·5	20	30	25	50	100
Maximum loss in per cent......	10	15	20	2·5	5	10
Average loss in per cent.	4	6	8	1	2	4
Average efficiency	96	94	92	99	98	96

These two tables show the individual efficiency of the different portions of the two systems, and the total efficiency from the driving belt up to and including the portions named. I have granted in all cases for the converter system an efficiency of 98 per cent. for the primary, and 99 per cent. for the secondary conductors. With a commercial efficiency of 90 per cent. for the generator, and 95 per cent. for the converter, which is sometimes claimed for them by some, the total efficiency is 82·9 per cent. With a commercial efficiency of 85 per cent. for the generator, and 90 per cent. for the converter, which is believed by others to be liberal, the total efficiency is 74·2 per cent. In the three-wire system we have assumed an efficiency of the generator of 92 per cent., which result is obtained by every maker of a first-class dynamo of this type, and an efficiency of 99 per cent. for both the mains and the inside wiring, both of which portions of the system are in practice calculated for a maximum loss of 2 per cent.

The maximum loss in the feeders in Table No. 2 is made 10, 15 and 20 per cent., with a corresponding average loss of 4, 6 and 8 per cent., and an efficiency of 96, 94 and 92 per cent.

TABLE II.

Alternating-Current Converter System.

	Indv.	Total.	Indv.	Total.	Indv.	Total.
Efficiency of generator.........	90	90	88	88	85	85
Efficiency of feeder	98	88·2	98	87·2	98	83·3
Efficiency of converter.........	95	83·8	92	79·3	90	75
Efficiency of services and inside wiring	99	82·9	99	79·5	99	74·2

Three-Wire System.

	Indv.	Total.	Indv.	Total.	Indv.	Total.
Efficiency of generator.........	92	92	92	92	92	92
Efficiency of feeder	96	88·2	94	86·5	92	84·6
Efficiency of mains	99	87·3	99	85·6	99	83·7
Efficiency of services and inside wiring	99	86	99	84·7	99	82·9

Assuming the highest efficiency claimed for the alternating-current generator, and assuming the generator is as efficient as a continuous-current generator under conditions of partial load—which is not likely—and assuming that the converter has the same efficiency under partial load as under full load—which we know cannot be—we still are met with the fact that the three-wire system with a maximum loss of 20 per cent. in the feeders has as high an efficiency as the converter system, allowing it every possible claim, and that the three-wire system as usually installed, with a maximum of 10 per cent. loss in feeders, has a superior efficiency of from 4 to 12 per cent. over the alternating-current converter system.

To return now to the question of first cost, assuming the cost of copper at 16 cents per pound, I have figured the cost of copper con-

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ductors for feeders for 16 candle-power; 50-watt lamps for distances of 1,000, 2,000, 3,000, 4,000, 5,000, and 6,000ft., with an average loss in conductors of 4, 6, and 8 per cent. for the three-wire system, and 2 per cent. for the alternating system with 1,000 volts initial E.M.F.; cost is expressed in dollars and decimal fractions thereof.

TABLE III.

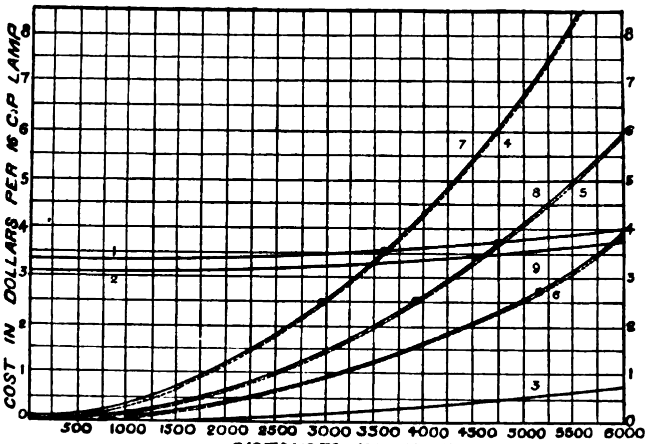
Cost of Copper for Three-Wire Feeder, per 16 candle-power lamp (50 watts 110 volts). Copper at 16 cents per lb.

Distances	1,000	2,000	3,000	4,000	5,000	6,000
12·5 volts maximum loss equals 5 volts average loss, which is 4 per cent.	·266	1·064	2 394	4·256	6·65	9·576
20 volts maximum loss equals 8 volts average, which is 6 per cent.	·1615	·646	1·453	2·584	4 037	5·812
30 volts maximum loss equals 12 volts average, which is 8 per cent.	·1077	·430	·969	1·723	2 69	3·87

Cost of Primary and Secondary Circuits and Converters for 1,000 Volt Alternating-Current Converter System, per 16 candle-power lamp, at varying distances.

Distances	1,000	2,000	3,000	4,000	5,000	6,000
Primary	·0213	·085	·191	·340	·530	·764
Converter	3 000	3·000	3·000	3·000	3·000	3·000
Secondary	·240	·240	·240	·240	·240	·240
Total	3·2613	3·325	3·431	3·580	3·770	4·004

I have also calculated the cost of copper in the mains for one 16 candle-power lamp on the basis of a distance of 800ft. between feeder terminals in the three-wire system and a maximum loss of 2 per cent., and find it to be thirteen cents. Also the cost of services and inside wiring in the three-wire system on basis of an average distance to lamps of 100ft., and 2 per cent. loss, and since the full benefit of the three-wire distribution cannot be attained in the inside wiring, have assumed the saving of one-third over the two-wire system instead of the two-thirds saving effected in cases where the full benefit can be attained. On this basis the cost of copper for services and inside wiring is six and one-half cents per lamp.



In the alternating-current converter system I have assumed the cost of converters recently quoted by Mr. Stanley, the electrician of the Westinghouse Company, in a Paper before the Boston Society of Arts. This figure is three dollars per lamp. I have calculated the cost of copper per 16 candle-power 50-volt and 50-watt lamp with an average distance to the lamp of but 75ft., and with 2 per cent. loss, and found the cost of copper to be 24 cents per lamp. With an average distance of 100ft., as was assumed in the case of the three-wire system, the cost of conductors for the inside wiring would be 43 cents. In making the comparisons, however, we will give them the advantage due to the 75ft. distribution; that is, 24 cents per lamp.

I have plotted these results expressing cost as ordinates, and distances as abscissæ. The curves resulting are shown here. [See diagram.]

In the diagram, curve number 1 shows cost of primary converter and secondary for alternating system (converters at $3 per lamp).

Number 2 shows cost of primary and converter for alternating system.

Number 3 shows cost of primary for alternating system.

Number 4 shows cost of feeders for average loss of 4 per cent.

Number 5 shows cost of feeders for average loss of 6 per cent.

Number 6 shows cost of feeders for average loss of 8 per cent.

Number 7 shows cost of feeders and mains for average loss of 9 per cent.

Number 8 shows cost of feeders and mains in the three-wire system for average loss of 6 per cent.

Number 9 shows cost of feeders and mains in the three-wire system for average loss of 8 per cent.

In the three-wire system curves for total cost are the lines in black just above the dotted lines.

It will be seen that if the three-wire system be operated at an average efficiency of 92 per cent. in the feeder, which corresponds to the highest efficiency claimed for the alternating-current converter system, the total cost per lamp would be equal when the average length of feeder was 6,000ft. An average length of feeder of 6,000ft. corresponds to circular area 18,000ft. in diameter; that is, about 3½ miles in diameter. In practice, it is preferable to operate at higher efficiency, making a large investment in copper, which has the strong recommendation of having the least depreciation, and requiring the least attention of anything used in connection with the transmission of energy.

The middle curves represent an average efficiency of 94 per cent. in the feeder; that is, an average loss of 6 per cent. in the feeder. You will notice that even with this superior efficiency the three-wire system is cheaper per lamp than the alternating-current converter system at an average length of feeder of 4,750ft., corresponding to a circular area of 12,000ft. in diameter, and that for shorter distances the cost rapidly diminishes—the cost of conductors for three-wire system at this efficiency with an average length of feeder of 3,000ft. corresponding to circular area of 9,000ft. in diameter being less than one-half the cost of conductors and converters for the alternating system.

Even with the very high efficiency of 96 per cent. in the feeder, or an average loss of but 4 per cent., the conductors of the three-wire system are cheaper than the conductors and converters of the alternating-current converter system for an average length of feeder of 3,600ft. or less, and this corresponds to a circular area of 11,000ft. in diameter.

Suppose that both the generator and converter are so much cheaper than we have assumed as above that it makes a total reduction of one dollar per lamp. We then find that under conditions of equal efficiency, 82·9 per cent., the three-wire is cheaper where the average distance to lamps is one mile or less. With the usual efficiency for the three-wire system, 84·7 per cent., it is the cheaper for an average distance to lamps of 4,000ft. or less, and with the highest efficiency, that is, 86·5 per cent., with average loss of 4 per cent. in the feeders, the three-wire system would be the cheaper when the average distance to lamps is 3,000ft. or less.

Suppose, on the other hand, that the incandescent lamp be doubled in voltage, and increased 25 per cent. in economy; at the same time that the cost of converter was reduced to two-thirds its present cost, and we find that with the highest efficiency, 96 per cent. in the feeders, the three-wire system would be the cheaper for cases where average distance to lamps is 8,000ft. or less, which corresponds to a circular district about five miles across.

Before leaving the question of economy of operation, let us look at the question of depreciation. In any dynamo the depreciation naturally becomes greater when it is operated at high E.M.F., even where the type is the same, and in the high E.M.F. alternating-current generator there exists the greatest tendency toward troubles due to the breaking down of the insulation of the wire on the armature. The secondary circuit of the alternating-current system and the inside wiring of the three-wire system would have a similar depreciation, but there is a great difference between the depreciation of copper conductors carrying low E.M.F. continuous currents and the depreciation of highly insulated conductors carrying a high E.M.F. alternating current together with the depreciation on an expensive piece of apparatus like the converter, the large proportion of the cost of which is represented by labour. Try to compare the value of copper twenty years hence which costs $1,000 to-day with $1,000 of converters, and small highly insulated wire such as is used in the primary circuit of the alternating system, and I think it will be evident that the depreciation of the alternating system is going to be many times that of the three-wire system.

Reliability.—In ordinary practice in the three-wire system every lamp is partially supplied by every feeder on that side of the system. That is, the current can flow out on any such feeder and through the network of mains, and finally reach the individual lamp. Similarly, every lamp is supplied in part by every dynamo operating in multiple arc on that side of the system, so that the larger the system, the more reliable it becomes, and an accident to

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an individual main, feeder, dynamo belt or engine does not in any way affect the operation of the light, and in the worst event trouble in an individual building would only result in half the lamps on that circuit going out, and the other half would be scattered alternately among those which would go out, so that the result would not be even troublesome.

Now how about the alternating system? Thus far they have not found it practicable to operate their generators in multiple arc, and it is not likely that they will ever be able to in common practice. This means more than is generally appreciated. Every lamp burning on an alternating system depends upon the continuous operation in unison of six separate appliances, each of which is liable at any moment to cause an instantaneous extinction of the light in question. These six things are :—

First. The individual secondary circuit which supplies the lamp.
Second. The individual converter which supplies the lamp.
Third. The individual primary circuit which supplies the lamp.
Fourth. The individual generator which supplies the lamp.
Fifth. The individual belt for the generator.
Sixth. The individual engine which supplies the power.

The next best thing to reliability is ability to reduce the time the light is out to a minimum, and to accomplish this it becomes necessary to install a spare system of conductors which are only brought into service when a primary circuit gets into trouble. An expensive switch-board in the central station also becomes necessary, so that in case of trouble to a generator its load can be thrown over to another generator with the least possible effect upon the lights that the generator has been supplying. The secondary circuits from one primary can be multiple arced, and this is sometimes done, and this adds somewhat to the reliability of the light, but the expense due to this connecting of converters by heavy wires required by 50-volt lamps makes it impracticable in usual instances.

Unless the alternating-current generators are operated in multiple arc, the reliability of the alternating system cannot be as good as that of an arc light system, and we all know how reliable that is.

Variety and Value of the Possible Sources of Revenue.—We now come to the consideration of the variety and value of the possible sources of revenue. The first and most important revenue for a central lighting station outside of the light itself is power.

In a central station running night and day, the cost of generating additional power beyond that required for the light is quite small—probably not exceeding $30 per horse-power per year for ten hours per day. This amount of power distributed in small units as required in practice will readily sell for $100 per year. Owing to the fact that a large number of small motors, varying in their requirements as to power from moment to moment, are supplied from one common source, a certain production of horse-power will supply the demands of motors representing a total maximum horse-power some 2½ times as much as is produced. In other words, for every horse-power produced at $30 you can sell 2½ at $100 each, or you can sell for $250 what it has cost you $30 to produce. It goes without saying that the ability to supply such demands is of the utmost importance to a central station. The continuous-current system is well adapted to the supply of power for any and all purposes. No practical method of operating a motor by means of the alternating current has as yet been devised, and the problem presents great difficulties, principally on account of the necessity of a comparatively continuous current for charging the fields, and the instability of the torque of such a motor.

We are promised great results and extended use of the storage battery, and undoubtedly it will be used considerably for a great many purposes, therefore there is a large possible revenue from this source, which the alternating system will not be able to supply.

Then there is almost unlimited number of applications of a continuous current on a small scale for such purposes as fire alarms, burglar alarms, distribution of time, annunciators, tickers, electroplating, telegraph lines and telephones, all of which rely on a continuous current; and there are innumerable applications which will soon develop consequent upon the absolute reliability and constancy of the electrical pressure at command. Out of the numberless applications of the electric current which we see daily, I can think of no commercial application except the production of light and heat, for which the alternating current under discussion is available, and the production of heat by the electric current does not present a flattering outlook as a source of revenue to the owners of central station plants. Therefore we see that to-day the alternating system is dependent for its revenue upon the sale of light alone, while the continuous current is applicable to almost every conceivable use to which the electric current is put.

Safety to Life.—The safety to life of the three-wire continuous-current system using about 230 volts as a maximum E.M.F. is undoubtedly absolute. It is impossible for a consumer of such a system to injure himself by the shock in any conceivable way, and a slight burn in case he makes a short circuit in too close proximity to some portion of his person is the worst result possible, and this is almost an unheard-of possibility. It has been conclusively proven in practice that the 1,000-volt alternating current is fatal to human life, and will kill a horse. Although perhaps not likely to occur, it is always possible for the primary and secondary to get into contact either in the converter itself, or possibly in circuits outside of it. Any person handling the wires of the secondary and a fairly good ground is then liable through a possible ground elsewhere to be instantaneously killed. The most dangerous thing is the one which is usually perfectly safe, and occasionally dangerous, as is witnessed by the death of a telephone operator at Pittsburg recently. While he was, as usual, handling various contacts about the switch-board, a high electromotive force circuit became closed somewhere outside with the telephone line, and without the slightest suspicion of any possible danger he was instantly killed in doing what he had done thousands of times before.

Effects Upon Existing Property.—The low E.M.F. of the ordinary three-wire system, the perfect protection from excessive current effected by the safety devices in use and the continuous character of its current render it practically inert as far as its influence upon existing property is concerned. That the alternating system, with its high E.M.F. and its strong inductive influence, will occasionally cause serious trouble to existing telegraph, telephone and other lines, which it is adjacent to, seems inevitable.

From the foregoing comparisons, I consider the alternating current is not applicable to central station lighting, as it is at present operated, except as a possible occasional adjunct, or else upon an extremely small scale in cases where a few lights very greatly scattered are required, and where power is cheap. In cases where cheap power exists at a distance of several miles from a town capable of supporting a station of 2,000 lamps and upwards, high initial E.M.F. becomes both desirable and necessary, but the continuous-current converter, which already exists in several forms, and which is receiving the attention of the best electricians and inventors of the world, will, in my opinion, be the device to supply this demand, and that very shortly.

JUDGMENT OF THE SUPREME COURT OF THE UNITED STATES IN THE TELEPHONE APPEALS.

Mr. Justice BLATCHFORD: This opinion is in case No. 113, *Amos E. Dolbear* and other appellants, versus *The American Bell Telephone Company*, an appeal from the Circuit Court of the United States for the District of Massachusetts.

In cases No. 361 and 362, which are cross-appeals from the Circuit Court of the United States for the Southern District of New York, one by the *Molecular Telephone Company* and others, appellants, against *The American Bell Telephone Company* and another, and a cross appeal by *The American Bell Telephone Company* and another, versus *The Molecular Telephone Company* and others.

Another case is No. 709, *The Clay Commercial Telephone Company* and others, appellants, versus *The American Bell Telephone Company* and others, an appeal from the Circuit Court of the United States for the Eastern District of Pennsylvania.

Another is case No. 770, *The People's Telephone Company* and others, appellants, against *The American Bell Telephone Company* and others, an appeal from the Circuit Court of the United States for the Southern District of New York.

Another is case No. 771, *The Overland Telephone Company* and others, appellants, against *The American Bell Telephone Company* and others, an appeal from the Circuit Court of the United States for the Southern District of New York.

The opinion is written by the Chief Justice.

BELL'S CLAIM FOR THE ART.

The important question which meets us at the outset in each of these cases is as to the scope of the fifth claim of Bell's patent of March 7th, 1876, which is as follows :—

"The method of and apparatus for transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth."

It is contended that this embraces the art of transferring to or impressing upon a current of electricity the vibrations of air produced by the human voice in articulate speech, in such a way that the speech will be carried to and received by a listener at a distance on the line of the current. Articulate speech is not mentioned by name in the patent. The invention, as described, consists in the employment of a vibratory or undulatory current of electricity, in contradistinction to a merely intermittent or pulsatory current, and of a method of and apparatus for producing electrical undulations upon the line wire.

A pulsatory current is described as one caused by sudden or instantaneous changes of intensity, and an electrical undulation as the result of gradual changes of intensity, exactly analogous to the changes in the density of air occasioned by simple pendulous vibrations.

Among the uses to which this art may be put, is said to be the tele-

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graphic transmission of noises or sounds of any kind; and it is also said that the undulatory current, when created in the way pointed out, will produce through the receiver at the receiving end of the line, a similar sound to that uttered into the transmitter at the transmitting end. One of the means of imparting the necessary vibrations to the transmitter to produce the undulations may be the human voice. Articulate speech is certainly included in this description, for it is an uttered sound produced by the human voice.

It is contended, however, that "vocal sounds" and "articulate speech" are not convertible terms, either in acoustics or in telegraphy. It is unnecessary to determine whether this is so or not. Articulate speech necessarily implies a sound produced by the human voice. As the patent, on its face, is for the art of changing the intensity of a continuous current of electricity by the undulations of the air caused by the sonorous vibrations, and speech can only be communicated by such vibrations, the transmission of speech in this way must be included in the art. The question is not whether vocal sounds and articulate speech are used synonymously as scientific terms, but whether articulate speech is one of the vocal or other sounds referred to in this claim of the patent. We have no hesitation in saying that it is, and that if the patent can be sustained to the full extent of what is now contended for, it gives to Bell, and those who claim under him, the exclusive use of this art for that purpose until the expiration of the statutory term of his patented rights.

In this art, or what is the same thing under the patent law, this *process*, this *way* of transmitting speech, electricity, one of the forces of nature, is employed; but electricity left to itself will not do what is wanted. The art consists in so controlling the force as to make it accomplish the purpose.

It had long been believed that if the vibrations of air caused by the voice in speaking could be reproduced at a distance by means of electricity, the speech itself would be reproduced and understood. How to do it was the question. Bell discovered that it could be done by gradually changing the intensity of a continuous electrical current, so as to make it correspond exactly to the changes in the density of the air caused by the voice. This was his art. He then devised a way in which these changes of intensity could be made and speech actually transmitted. Thus his art was put in a condition for practical use. In doing this, both discovery and invention, in the popular sense of those terms, were involved; discovery in finding the art, and invention in devising means of making it useful; and for such discovery and such invention the law has given the discoverer and inventor the right to a patent; as discoverer for the useful art, process and method of doing the thing he has found, and as inventor for the means he has devised to make the discovery one of actual value. Other inventors may compete with him for the ways of giving effect to the discovery, but the new art he has found will belong to him and those claiming under him during the life of his patent. If another discovers a different art or method of doing the same thing, reduces it to practical use, and gets a patent for his discovery, the new discovery will be the property of the new discoverer, and thereafter the two will be permitted to operate, each in his own way, without interference by the other. The only question between them will be whether the second discovery is in fact different from the first.

A patent for the art does not necessarily involve a patent for the particular means employed for using it. Indeed, the mention of any means in the specification or descriptive portion of the patent is only necessary to show that the art can be used; for it is only useful arts, arts which may be used to advantage, that can be made the subject of a patent. The language of the Statute is:—

"Any person who has invented or discovered any new or useful art, machine, manufacture or composition of matter may obtain a patent."

That is section 4886 of the Revised Statutes. It is an art, a process which is useful, and is as much the subject of a patent as a machine, manufacture or composition of matter. Of this there can be no doubt. It is abundantly supported by the authorities. *Corning* v. *Burden*, 15 How., 252-271. *Tilghman* v. *Proctor*, 12 How., 707-735. *Fermentation Company* v. *Maus*, 20 Fed. Rep., 725.

What Bell claims is the art of creating changes of intensity in a continuous current of electricity exactly corresponding to the changes of density in the air caused by the vibrations which accompany vocal or other sounds, and of the use of the electric condition that is thus created for sending and receiving articulate speech telegraphically. For that, among other things, the patent of 1876 was, in our opinion, issued, and the point to be decided is whether as such a patent it can be sustained.

In *O'Reilly* v. *Morse* (15 How.) it was decided that a claim in broad terms for the use of the motive power of the electric or galvanic current for making intelligible characters, letters or sounds at any distance, although a new application of the power was made by Morse, was void, because it was a claim for a patent for an effect produced by the use of electro-magnetism, distinguished from the process or machinery necessary to produce it.

But a claim for making use of the motive power of magnetism when developed by the action of said current, substantially as set forth in the foregoing description, as a means of operating or governing the motion or machinery that is to impart signals in any desired manner for the purpose of producing telegraphic communication at any distance, was sustained. The effect of the decision was, therefore, that the use of magnetism as a motive power, without regard to the particular process with which it was connected in the patent, could not be claimed, but that its use in such a connection could.

In the present case the claim is not for the use of a current of electricity in its natural state, as it comes from the battery; but for putting a continuous current in a closed circuit into a certain specific condition suited to the transmission of vocal and other sounds, and using it in that condition for that purpose. So far as at present known, without this peculiar change in its condition it will not serve as a medium for the transmission of speech, but with the change it will. Bell was the first to discover this fact and how to put such a current into such a condition. What he claims is its use in that condition for that purpose, just as Morse claimed his current in his condition for his purpose. But we see nothing in the Morse case to defeat Bell's claim. On the contrary, it is in all respects sustained by that authority. It may be that electricity cannot be used at all for the transmission of speech except in the way Bell has discovered it, and that therefore practically his patent gives him its exclusive use for this purpose. But that does not make his claim one for the use of electricity as distinguished from the particular process with which it is connected in his patent. It will, if it is true, show more clearly the great importance of his discovery, but it will not invalidate his patent.

SUFFICIENCY OF THE SPECIFICATION.

But it is insisted that his claim cannot be sustained, because, when the patent was issued Bell had not in fact completed his discovery. While it is conceded that he was acting on the right principle, and had adopted the true theory, it is claimed that his discovery lacked that practical development which was necessary to make it patentable. In the language of counsel "there was still work to be done, work calling for the exercise of the utmost ingenuity, and calling for the very highest degree of practical invention."

It is quite true that when Bell applied for his patent he had never actually transmitted telegraphically spoken words so that they could be distinctly heard and understood by the listener at the receiving end of his line; but in his specification he did describe accurately and with admirable clearness his process—that is to say, the exact electrical condition that must be created to accomplish the purpose. He also described with sufficient precision to enable one skilled in such matters to make it, a form of apparatus, which, if used in the way pointed out, would produce the required effect, receive the words and carry them to and deliver them at the appointed place. The particular instrument which he had, and which he used in his experiments, did not, under the circumstances in which it was tried, reproduce the words spoken so that they could be clearly understood; but the proof is abundant and of the most convincing character that other instruments carefully constructed and made in exact accordance with the specifications without any additions whatever have operated and will operate successfully. A good mechanic of proper skill in matters of the kind can take the patent, and by following the specification strictly, can construct an apparatus which, when used in the way pointed out, will do all that it is claimed the method or process will do.

Some witnesses have testified that they were unable to do it, but this shows that they, with the particular apparatus they had and the skill they employed in its use, were not successful; not that others with another apparatus perhaps more carefully constructed or more skilfully contrived would necessarily fail. As was said in *Loom Company* v. *Higgins*, when the question is whether a thing can be done or not it is always easy to find persons to show how not to do it. If one succeeds, that is enough, no matter how many others fail. Opposite results will show that in the one case the apparatus used was properly made, and carefully adjusted with a knowledge of what was required, and skilfully used; and that in the other it was not. The law does not require that a discoverer or inventor, in order to get a patent for a process, must have succeeded in bringing the art to the highest degree of perfection. It is enough if he describes the method with sufficient clearness and precision to enable those skilled in the matter to understand exactly what the process is, and if he points out some practical way of putting it in operation. This Bell did.

He described clearly and distinctly his process of transmitting speech telegraphically by creating changes in the intensity of a continuous current or flow of electricity in a closed circuit, exactly analogous to changes of density in the air occasioned by the undulatory motion given to it by the human voice in speaking. He then pointed out two ways in which this might be done, one by the vibration or motion of bodies capable of inductive action, or by the vibration of the conducting wire itself in the neighbourhood of such bodies; and the other by alternately increasing and diminishing the resistance of the circuit, or by alternately increasing and diminishing the power of the battery. He then states that he prefers to employ for his purpose an electro-magnet having a coil on one of its legs, and he describes the construction of the particular apparatus, shown in the patent as figure 7, in which the electro-magnet or magneto method was employed. This was the apparatus which he himself used without entirely satisfactory results, but which Prof. Cross, Mr. Watson, Dr. Blake, Mr. Pope and others, testify has done and will do what was claimed for it—transmit speech successfully, but not as well indeed as another constructed upon the principle of the microphone or variable resistance method.

THE PATENT NOT LIMITED TO SPECIFIC APPARATUS.

An effort was made in the argument to confine the patent to the magneto instrument and such modes of creating electrical undulations as could be produced by this form of apparatus, the position being that such an apparatus necessarily employed a closed circuit incapable of being opened, and a continuous current incapable of being intermittent. But this argument ignores the fact that the claim is, first, for the process, and, second, for the apparatus. It is to be read, as *first*, a claim for the method of transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations similar in form to the vibrations of air accompanying the vocal or other sounds substantially as set forth, and, *second*, for an apparatus for transmitting vocal or other sounds telegraphically as herein described, by causing electrical undulations substantially as set forth.

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The *method*, "as herein described," is to cause gradual changes in the intensity of the electrical current used as the medium of transmission, which shall be exactly analogous to the changes in the density of the air occasioned by the peculiarities in the shapes of the undulations produced in speech, in the manner substantially as set forth; that is to say, by the vibration or motion of bodies capable of inductive action, or by the vibration of the conducting wire itself in the neighbourhood of such bodies, which is the magneto method: or by alternately increasing and diminishing the resistance of the circuit, or by alternately increasing and diminishing the power of the battery, which is the variable resistance method. This is the process which has been patented, and it may be operated in either of the ways specified. The circuit must be kept closed to be used successfully; but this does not necessarily imply that it must be so constructed or so operated upon as to be incapable of being opened. If opened, it will fail to act for the time being, and the process will be interrupted; but there is nothing in the patent which requires it to be operated by instruments which are incapable of make and break. The *apparatus*, "as herein described," which is included in the claim, is undoubtedly one in which the electro-magnet is employed, constructed substantially as set forth in the specification. The one acting on the variable resistance mode is not described further than to say that the vibration of the conducting wire in mercury or other liquid included in the circuit occasions undulations in the current; and no very specific directions are given as to the manner in which it must be constructed. The patent is both for the magneto and variable resistance *methods* and particularly for the magneto *apparatus* which is described or its equivalent. There is no patent for any variable resistance *apparatus*.

It is undoubtedly true that when Bell got his patent he thought the magneto method was the best; indeed, he said in express terms he preferred it. But that does not exclude the use of the other, if it turns out to be the most desirable way of using the process under any circumstances. Both forms of apparatus operate on a closed circuit by a gradual change of intensity, and not by alternately making and breaking the circuit or by sudden and instantaneous changes, and they each require to be so adjusted as to prevent interruptions. If they break, it is a fault, and the process stops until the connection is restored.

It is again said that the claim, if given its broad construction, is virtually a claim for speech transmission by transmitting it, or in other words, for such doing of the thing as is provable by doing it. It is true Bell transmits speech by transmitting it, and that long before he did so it was conceived by scientists that it could be done by means of electricity. if the requisite electrical effect could be produced. Precisely how that subtle force operates under Bell's treatment, or what form it takes, no one can tell. All we know is, that he found that by changing the intensity of a continuous current so as to make it correspond exactly to the changes in density of the air caused by sonorous vibrations, vocal and other sounds could be transmitted and heard at a distance. This is the thing to be done. Bell discovered the way of doing it. He uses electricity as the medium for that purpose, just as air is used within speaking distance. In effect, he prolongs the air vibrations by the use of electricity. No one before him had found out how to use electricity with the same effect. To use it with success it must be put in a certain condition. What that condition was he was the first to discover, and with his discovery he astonished the scientific world. Prof. Henry, one of the most eminent scientists of the present century, spoke of it as the greatest marvel hitherto achieved by the telegraph. The thing done by Bell was the transmitting of audible speech through long telegraph lines. Sir William Thomson on returning to his home in England in August or September, 1876, after seeing at the Centennial Exhibition in Philadelphia what Bell had done and could do by his process, spoke in this way of it to his countrymen:—

"Who can but admire the hardihood of invention which devised such a slight means to realise the mathematical conception, that if electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of the current must vary continuously as nearly as may be in simple proportion to the velocity of the particle of air engaged in constituting the sound."

Surely a patent for such a discovery is not to be confined to the mere means he improvised to prove the reality of his conception.

BELL'S METHOD NOT IN REIS' APPARATUS.

We come now to consider the alleged anticipation of Philipp Reis; and here it is always to be kept in mind that the question is not whether the *apparatus* devised by Reis to give effect to his theory can be made with our present knowledge to transmit speech, but whether Reis had in his time found out a way of using it successfully for that purpose; not as to the character of the apparatus, but as to the mode of treating the current of electricity on which the apparatus is to act, so as to make that current a medium for receiving vibrations of air created by the human voice in articulate speech at one place, and in effect delivering them at the ear of the listener in another place. Bell's patent is not alone for the particular apparatus that he describes, but for the process that apparatus was designed to put into use. His patent would be just as good if he had actually used the Reis apparatus in developing the process for which it was granted. That Reis knew what had to be accomplished in order to transmit speech by electricity is very apparent, for in his first paper he said:—

"Since it is possible to produce anywhere or in any manner vibrations whose curves shall be the same as those of any given tone or combination of tones, we shall receive the same impression as that tone or combination of tones would have produced on us."

Bourseul also knew before Reis that this was the case, for in a communication published in the Paris journals in 1854 he said:—

"When you reproduce precisely these vibrations, to wit, the vibrations made by the human voice in uttering syllables, you will reproduce precisely those syllables."

Reis discovered how to reproduce musical tones, but he did no more. He could sing through his telephone, but he could not talk. From the beginning to the end he has conceded this. In his first paper he said:—

"Hitherto it has not been possible to produce the tones of human speech with a distinctness sufficient for every one. The consonants are for the most part reproduced pretty distinctly, but the vowels as yet not in an equal degree. The cause of this I will attempt to explain."

And again:—

"I have succeeded in constructing an apparatus with which I am enabled to reproduce the tones of various instruments, and even to a certain extent the human voice."

None of the many writers whose papers are found in the records claim more than this for Reis or his discovery. Although his first paper was published in 1861, Bell did not appear as a worker in the field of scientific research until nearly fifteen years afterwards. No advance had been made by the use of what Reis had contrived, nor by the use of his method, towards the great end to be accomplished. He caused his instrument to be put in the market for sale, and both he and those he employed for that purpose took occasion to call attention to the instruments by their prospectus, catalogues, and otherwise, describing what they were and what they would do. In his own prospectus, which was published in 1863 and attached to the apparatus, he said:—

"Every apparatus consists of two parts, the telephone proper and the receiver. These two parts are placed at such distance from each other that the singing or toning of a musical instrument can be heard in no other way from one station to the other except through the apparatus.

"Both parts are connected with each other and with the battery B, like common telegraphs. . . The galvanic current goes . . . . through the copper strip to the platinum leaf on the middle of the membrane, then through the foot of the angle to the screw *b*, in whose hollow a small drop of mercury is placed. . .

"If now sufficiently strong tones are produced in front of the sound-opening S, through the vibrations of the same, the membrane and the angular-shaped little hammer lying upon it are set in vibration; *the circuit is alternately opened and closed at every full vibration* and hereby are produced in the iron rod of the spiral at station C the same number of vibrations, and those are perceived there as tone or tone combinations.

"Besides the human voice there can be produced (according to my experience) just as well the tone of good organ pipes from F—c and those of the piano."

Albert, the mechanician employed to make the instruments, in his catalogue published in 1866, enumerates among the things he has for sale "the telephone of Reis for reproducing tones by electricity;" and in a work on electricity by Ferguson, published in London and Edinburgh, in 1867, it is said in speaking of the telephone:—

"This is an instrument for telegraphing notes of the same pitch. Any noise producing a single vibration of the air, when repeated regularly a certain number of times a second, not less than 32, produces, as is well known, a musical sound. A person when singing any note causes the air to vibrate so many times per second, the number varying with the pitch of the note he sings. The higher the note the greater the number of vibrations. If we then by any means can get these notes to break a closed circuit, a note sung at one station can be reproduced, at least so far as pitch is concerned, at another. The Reis telephone, invented in 1861, accomplishes this in the following way."

It is needless to quote further from the evidence on this branch of the case. It is not contended that Reis ever succeeded in practically transmitting speech, but only that his instrument was capable of it if he had known how. He did not know how. All his experiments in that direction were failures. With the help of Bell's later discoveries in 1875, we now know why he failed.

As early as 1854 Bourseul, in his communication which has already been referred to, had said substantially that if the vibrations of air produced by the human voice in articulate speech could be reproduced by means of electricity at a distance the speech itself would be reproduced and heard there. As a means of stimulating inquiry to that end he called attention to the principle on which the electric telegraph was based, and suggested the application of that principle for such a purpose. He said:—

"The electric telegraph is based on the following principle:—An electric current passing through a metallic wire circulates through a coil around a piece of soft iron, which it converts into a magnet. The moment the current stops this piece of iron ceases to be a magnet. This magnet takes the name of electro-magnet.

"This magnet, the electro-magnet, can thus alternately attract or let go a movable plate, which by its movements back and forth produces the conventional signals used in telegraphy."

Then, after referring to the mode in which speech is transmitted by the vibrations of the air, he said:—

"Suppose a man speaks near a movable disc sufficiently flexible to lose none of the vibrations of the voice, and that this disc alternately makes and breaks the connection with the battery; and you may have at a distance another disc which may simultaneously execute the same vibrations."

That Reis was working all this time, from the beginning to the end of his experiments, upon the principle of the telegraph as thus suggested by Bourseul is abundantly proved. In his first paper, after describing his cubical block apparatus, he said:—

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"If, now, tones, or a combination of tones, are produced in the neighbourhood of the blocks, so that sufficiently powerful waves enter the opening *a*, then these sounds cause the membrane *b* to vibrate. At the first condensation the hammer-like wire *d* is pushed back; at the rarefaction it cannot follow the retreating membrane, *and the current traversing the strip remains broken*, until the membrane forced by a new condensation presses the strip (proceeding from *p*) against *d*. In this way *each sound causes a breaking and closing of the current.*"

Such was the beginning, and it was maintained persistently to the end, as well by Reis as by those who availed themselves of what he was doing. To this the Reis-Legat apparatus forms no exception, for in the paper describing it Legat says:—

"The operation of the apparatus described is as follows:

"When at rest the galvanic circuit is closed, when the air, which is in the tube *a b* of the apparatus, Fig. 4 A, is alternately condensed and rarefied by speaking into it (or by singing or introducing the tones of an instrument), a movement of a membrane closing the smaller opening of the tube is produced, corresponding to such condensation or rarefaction. The lever, *c d*, follows the movements of the membrane, and opens and closes the galvanic circuit at *d g*, so that at each condensation of the air in the tube the circuit is opened, and at each rarefaction the circuit is closed.

"In consequence of this operation, the electro-magnet of the apparatus, Fig. 4 B, in accordance with the condensations and rarefactions of the column of air in the tube *a b*, Fig. 4 B, is correspondingly demagnatised and magnetised, and the armature of the magnet is set into vibrations like those of the membrane in the transmitting apparatus."

We have not had our attention called to a single item of evidence which tends in any way to show that Reis, or anyone who wrote about him, had in his mind anything else than that the intermittent current caused by the opening and closing of the circuit could be used to do what was wanted. No one seems to have thought that there could be any other way. All recognised the fact that the minor differences in the original vibrations had not been satisfactorily reproduced, but they attributed it to the imperfect mechanism of the apparatus used, rather than to any fault in the principle on which the operation was made to depend.

It was left for Bell to discover that the failure was due not to workmanship, but to the principle which was adopted as the basis of what was to be done. He found that what he called the intermittent current, one caused by alternately opening and closing the circuit, could not be made, under any circumstances, to reproduce the delicate forms of the air vibrations caused by the human voice in articulate speech; but that the true way was to operate on an unbroken current, by increasing and diminishing its intensity. This he called a vibratory or undulatory current, not because the current was supposed to actually take that form, but because that language expressed with sufficient accuracy his idea of a current which was subjected to gradual changes of intensity, exactly analogous to the changes of density in the air occasioned by its vibrations. Such was his discovery, and it was new. Reis never thought of it, and he failed to transmit speech telegraphically. Bell did, and he succeeded. Under such circumstances it is impossible to hold that what Reis did was an anticipation of the discoveries of Bell. To follow Reis is to fail, but to follow Bell is to succeed. The difference between the two is just the difference between failure and success. If Reis had kept on he might have found out the way to succeed; but he stopped and failed. Bell took up the work, and carried it on to a successful issue.

OTHER ALLEGED ANTICIPATIONS OF BELL'S METHOD.

As to what is shown to have been written and done by Dr. Van der Weyde, it is only necessary to say that he copied Reis, and it was not until after Bell's success that he found out how to use a Reis instrument so as to make it transmit speech. Bell taught him what to do to accomplish that purpose.

As to James W. M'Donough, we presume it will not be claimed that he is entitled to more than he asked for in his application for a patent, filed in the Patent Office, April 10th, 1876. There, a circuit-breaker so adjusted as to break the connection by the vibration of the membrane is made one of the elements of his invention. The Patent Office was clearly right in holding him to have been anticipated by Reis.

The patents of Cromwell Fleetwood Varley, of London, England, one dated June 2nd, 1868, and the other October 8th, 1870, were for improvements in the electric telegraph. The objects of the invention covered by the first are to cut off the disturbance arising from earth currents, and to obtain a high speed of signalling in long circuits; and the object of the second was the increase of the transmitting power by enabling more than one operator on a single wire to send more than one message to independent stations. In the specification it is said—

"By my invention I superpose upon the currents used for working the ordinary telegraphs rapid undulations or waves which do not practically alter the mechanical or chemical power of the ordinary signal currents, and by new apparatus, hereinafter described, these undulations are made to produce distinct and independent audible or other signals so long as these undulations are produced, whether ordinary signal currents be flowing or not."

In short, there is nothing in any part of the specification to indicate that the patentee had in his mind undulations resulting from gradual changes of intensity exactly analogous to the changes in the density of air occasioned by simple pendulous vibrations, which was Bell's discovery, and on which his art rests. His purpose was to superpose, that is to say to place upon the ordinary current another, which by the action of the make-and-break principle of the telegraph, would do the work he wanted.

(To be continued.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 24th*, 1888.

You have no doubt already been advised by cable of the rendering of the decision of the United States Supreme Court in the matter of the Bell patents. After litigation which extended back for several years, and after a prolonged period of suspense, those interested in the patents find themselves reassured and happy, and those who fought in the opposition are correspondingly disappointed and depressed. The legal fight has been one for length and costliness almost without precedent, and the issues at stake have been of the first magnitude. While the Court was not unanimous in its decision, and though the majority was far smaller than could be desired in establishing the validity of great fundamental patents, the triumph is none the less a fact. By the morning of Monday last little doubt was left that the decision would be rendered that day, and the telephone quotations in the Stock Market in Boston on the previous Saturday were higher and stronger than they had been some months past, the shares of the American Bell Telephone Company being quoted at 240, or just $100 per share more than at the time immediately preceding the decision against Drawbaugh by Judge Wallace. As soon as the Chief Justice began reading the decision in court it became tolerably clear that the verdict would be for Bell, and long before the end was reached it was seen that Bell's claims had been approved and reasserted in a manner which would make them hereafter practically unassailable. There were six cases up for review, being the suits won by the Bell Company against the Dolbear, Drawbaugh, Clay, Molecular, and Overland Companies, and the case in which the Molecular Company had obtained a decree against the Bell Company. The finding of the Court was that the various Reis apparatus were useful only and solely for transmitting musical tones, and that nothing that Reis had ever invented could affect the validity of the Bell patents. The trouble with Reis was, not merely bad workmanship in his instruments, but an utter failure to arrive at the only principle, as Bell did, upon which speech could actually be transmitted. Reviewing briefly the Dolbear, Van der Weyde, M'Donough, Varley and other claims as not really material, the Court then proceeded to pay its respects to the appeal of the People's Company, basing on the claims of Daniel Drawbaugh, the mechanic of Aberly's Mills, the little village in Pennsylvania, where we have been told the talking telephone was invented by Drawbaugh, as early as 1869. The Court admitted the profuseness of the evidence brought to support Drawbaugh's assertions, but discredited his story on the ground that his conduct had never been consistent with the idea that he had reached a complete discovery or invention which could be put to any practical use. The Court held that to suppose Drawbaugh had discovered the art of telephony before Bell did would be to construe testimony without regard to the laws that govern human conduct. It was on this point that the Court divided, a minority of three out of seven holding that this obscure mechanic of Pennsylvania did discover the practical telephonic art, and was entitled to the merit of being the first inventor. On no other point did the Court divide; the important claims of Dolbear, strange to say, being dismissed lightly, while the extravagant claims made by Drawbaugh had a weight which nobody had anticipated for them. The decision also included a discussion of the charges of collusion and fraud made against Bell and his attorneys, and the Court held that nothing had been brought to light that smirched in the slightest degree the professional integrity or moral character of those whose honour had been thus assailed.

Naturally this important decision is the engrossing topic at the present time. It cannot be said that the decision was at all unexpected, nor can it be said that it contains anything in the slightest degree new or original; in fact, we should have to go back to the Dowd, Spencer and Eaton cases for the first reference to Reis's alleged anticipations, and from 1881 down to the present time the story of

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the various inventors and anticipators has been told over and over again in the technical press and the daily journals until even mere allusion to the matter has become wearisome. The general opinion in professional circles appears to be that while for the extended use of the telephone it might have been well to open up opportunities for competition, the effect on patents generally is a wholesome one, by showing that patents can safely be made the basis of large new industrial developments. On the other hand, it is thought by some that this confirmation of what is regarded by a great many as a monstrous monopoly will lead to serious attempts to tamper with the patent system. As we have those attempts, anyhow, this decision cannot make the situation materially worse.

It hardly seems likely that we shall now see any serious attempts to start up the matter again by litigation, and with security promised them the various telephone companies may be expected to exert themselves in the direction of extending their business and solidifying their position. The probability is that the long-distance business will be pushed with greater rapidity than ever. It is surprising how great already is the network of long-distance wires. Thus, for example, we have Boston, New York, Philadelphia, and Washington all in a line able to communicate from one to the other, and it is an interesting fact worthy of note that on Monday when the decision was rendered bulletins as to the decision were received from minute to minute here in New York at telephone head-quarters over the long distance lines from Washington. Last week, in the middle of the great storm, when the telegraph wires broke right and left for hundreds of miles and were absolutely useless, the telephone lines came to our aid, and were found of the utmost service. Just what the Western Union is going to do about it we do not know yet, and there is room in this respect for speculation and conjecture.

I have just alluded to the storm; we are still recovering from it, and hardly yet, in the rush of extra work that it involves, have had time to define our sensations and realise what it really was. The damage done to the aërial wires proves to have been far heavier than even was at first supposed. In some places the destruction was complete. The telegraph lines between New York and Washington, for instance, will have to be almost entirely rebuilt, there being, so report goes, no fewer than 1,000 poles down between these two cities. The fact is that, although magnificent efforts have been made all around New York and Boston to put the lines in good shape, the repairs are in a great many cases only of a temporary character, sufficient to renew the service but not equal to the strain of continuous work. The Western Union Company has just declared its quarterly dividend of 1½ per cent., but the estimates do not include the blizzard, and as the loss will certainly be very large, the dividend may not be so substantial next quarter.

I believe you have already been advised of the intention of the Thomson-Houston Company to go into the electric railway business here. The electrical journals this week report that negotiations have now been concluded, and that the Van Depoele Company has transferred to the Thomson-Houston Company all its rights and patents in this department. It is generally understood that the Thomson-Houston Company will push the work in this field with its wonted dash and energy. It is fortunate in securing the assistance of Mr. C. J. Van Depoele, who is to devote himself to the development of the electric railroad system. Mr. Van Depoele, who is of Belgian extraction, is a very bright electrician, and a man whose indomitable pluck is only equalled by his unquenchable good humour. He has done much to give this country its prestige in electric railway matters, and amid all the troubles, disasters, and discouragements of the earlier days, has pegged away with a cheery doggedness that has been of incalculable value to this newest electrical application. I think that with the opportunities now presenting themselves, he will be able to make many marked improvements on his old work, and with the necessary capital to lead the way to a development for which no parallel can be found, even in our electric lighting annals.

Electrical Boston is very much stirred up just now by the efforts being made there to secure for certain parties the exclusive privilege to construct, establish, and maintain conduits for undergrounds of all descriptions. The applicants for the privilege say that if the city will put down the conduits, and then let them to different parties, they are perfectly willing to have the matter left in that shape; but if the city will not do it, then, in view of the emergency of the case, private capital should be invited by concessions; and it was a question, to which there could be but one answer, whether the authority should be given to one company to construct conduits which would carry all the wires, or whether a number of companies should be authorised each to put down its own conduits, and rip up the streets at its own sweet will. It goes without saying that the proposition meets with very strong objection. The telephone people do not wish to be compelled to use such conduits, having a system of their own. The arc light companies, backed by the expert opinion of Mr. C. J. H. Woodbury, very much prefer to see their wires overhead, and the Edison Company, with its own elaborate and effective underground system, thinks that it, of all others, should be exempted. Thus we have a variety of sentiment on the subject; and the Boston Board of Aldermen, sitting as a committee of the whole to hear arguments pro and con., is becoming so learned that even the member who last year orated about the "ducks" in the conduits is not likely to repeat his mistake. Speaking of underground wires reminds me that in view of the work of the late storm it has been suggested in various quarters that at least a few trunk wires between the large cities should be placed underground to provide against such an evil emergency as that of last week. The alternative to this plan is found in the proposition to connect the three great cities of the Atlantic coast, Boston, New York, and Philadelphia, by means of submarine cables running along the coast. It is pointed out that by such a method communication could never again be entirely interrupted. It is not unlikely that some such scheme will be carried out. Another lesson of the storm was that trains as well as cities should be kept in communication, and I hear that the Edison-Phelps train-telegraph system was of very great use last week on one of the snow-blocked lines, in enabling trains and passengers on board to communicate with the terminus of the line.

Reports come from Buffalo of some fairly successful trials made there with an Elieson motor, imported from England, to give a demonstration of the merits of electric traction. The event was hailed with much interest, and the mayor and all the aldermen enjoyed a ride.

NOTES FROM PARIS.

(FROM OUR OWN CORRESPONDENT.)

PARIS, *3rd April*, 1888.

The future prospect of electrical lighting in Paris has not improved since my last letter, and in spite of long sittings of the Conseil Municipal for the last three weeks, during which that important matter has been repeatedly under discussion, there is still no likelihood of any company undertaking the starting of public electric light stations. No less than six important companies are ready to furnish the light to all the central parts of the town whenever the regulations of the Municipal body will permit, but unless the *cahier des charges* imposed upon the contractors be amended in its most important provisions, there will be no chance for the visitors to the 1889 Exhibition seeing anything else but gas in the streets of Paris.

It will be sufficient to give some extracts from this document to show the prohibitory nature of the conditions imposed. The maximum price for a 16 candle-power incandescent light is fixed at 4½ centimes per hour. The *employés* must never work more than nine hours per diem, and their minimum wages are fixed at 80 centimes per hour from 6 a.m. to 6 p.m., 1fr. 20c. from 6 p.m. to midnight, and 1fr. 60c. from midnight to 6 a.m.

A yearly payment of 100fr. for every kilometre of wire or fraction thereof laid in the public streets is to be made to the city, with a sum representing 5 per cent. of the gross receipts

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of the company. But certainly the most absurd regulation is the following :—"The wiring will take the form of segments of a circle, going from the centre of Paris to the fortifications, and the companies must undertake to be ready to furnish the light to every part of their concession within four years." This regulation alone is sufficient to prevent any company from asking for a concession ; the distance from the centre to the fortifications varies from 6 to 10 kilometres, and if the consumers are pretty numerous within the 3 or 4 first kilometres, they will be very scarce for the rest, although the company would be bound to lay wires up to the last metre and to give light to the last house, even if it were only asked for a single lamp. The Conseil Municipal declares that it intends to fight the Parisian Gas Company ; but it has done quite the contrary, and apparently for a long time to come gas will still be the master.

The situation is better in the provinces, and instead of fighting against electric light the gas companies are themselves heading the revolution. Lyons, Marseilles, Toulouse, Clermont-Ferrand, Le Mans, Rheims, &c., see their gas companies preparing electrical plants, and the inhabitants of these cities and many others of smaller size will soon have the choice between gas and electricity.

CORRESPONDENCE.

THE GANZ WATTMETER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : The discussions which have lately been held about the wattmeter designed by me about four years ago, with a special view of using it for testing transformers, and the review of the pamphlet in your last issue are apt to throw discredit upon this instrument and those who use it in an undeserved extent. Though the objections raised by Prof. Ayrton and your reviewer against the accuracy of the wattmeter are based on a correct theoretical basis, they will yet not apply to the instrument under the conditions in which it is commonly used ; and I shall show that in the circumstances and the purpose the wattmeter was designed for, and hitherto used, its indications will come very near the truth. I shall also indicate how to make it an absolutely correct measuring device.

If r is the resistance of the fine-wire circuit,
L its self-induction coefficient,
r' and L′ corresponding terms for the circuit in which the power given is to be measured, and
$2n$ the number of current reversals per second,

then Prof. Ayrton's correction coefficient is

$$K = \frac{r}{r'} \cdot \frac{r r' + 4 n^2 \pi^2 L L'}{r^2 + 4 n^2 \pi^2 L^2}$$

(the current of the thin wire coil is supposed not to go through the stationary coil of the instrument).

This expresssion can be applied directly only when the whole power to be measured is really expended in the circuit under view itself ; while the *apparent values* for r' and L′ must be introduced into the formula when transformers or other apparatus are dealt with, in which secondary and Foucault currents and hysteresis of iron will consume energy outside of the thick-wire circuit, though supplied by the current pulsating in this.

A more general expression for the correction coefficient, and of which Prof. Ayrton's formula is a transformation, may be deduced in the following way :—

Let E and I respectively denote the square roots of mean squares of tension at terminals and current intensity for the circuit in which the power supplied is to be measured ; then this power is given by

$$E\,I \cos \lambda',$$

λ' being the angle of lag of the phase of current against phase of impressed E.M.F. at terminals of this circuit. This expression is true for any circuit whatever, provided we suppose E.M.F. and current to be sine functions of the time. If λ is the lag of phase of current in the fine-wire circuit of the wattmeter, then the reading of the instrument will be proportional to

$$E\,I \cos (\lambda' - \lambda) \,.\, \cos \lambda,$$

as may be shown by a simple calculus. The correction coefficient is therefore

$$K = \frac{\cos (\lambda' - \lambda) \cos \lambda}{\cos \lambda'} = \frac{1 + \tan \lambda \tan \lambda'}{1 + \tan \lambda^2} \quad . \quad . \quad (1)$$

and this will hold good in all cases.

For circuits which will not cause secondary currents or hysteresis of iron we have

$$\tan \lambda = \frac{-2\,n\,\pi\,L}{r} \text{ and } \tan \lambda' = -\frac{2\,n\,\pi\,L'}{r'},$$

which values introduced in the formula (1) at once transform it into that first indicated by Prof. Ayrton, having only a limited scope of application. Since tan λ is always a very small fraction, we may write

$$K = 1 + \tan \lambda \tan \lambda' \quad . \quad . \quad . \quad . \quad (2)$$

The wattmeter will therefore be a reliable instrument as long as tan λ tan λ' will remain a small fraction, say 1 per cent. as a maximum.

Now leaving circuits connected in any way with a condenser out of view, as the lag may there be exactly 90°, I have up to now never had opportunity of measuring power with a wattmeter in a circuit in which the lag between phase of E.M.F. and phase of current exceeded 87½°, with 100 alternations per second. Induction coils without iron must be of enormous size to get even at this value, while in coils with an iron core the Foucault current and hysteresis will prevent the lag from becoming sensibly equal to 90°. To take an extreme case let a standard 10 horse-power transformer, as manufactured by Messrs. Ganz and Company, be run on open secondary circuit with five times its normal tension and 200 alternations (2,000 volts and 83 alternations are the standard values), it would require 10,000 volts, take about 12 amperes, and the energy supplied wonld be something about 4,000 watts. The lag would amount to 88°. (When no hysteresis and no Foucault currents would take place, the angle of lag should be about 89° 58′.) But according to the instructions given in the pamphlet the fine-wire circuit should have in such a case 100,000 ohms. The self-induction coefficient of the movable coil of the wattmeter as actually made amounts to only 0·0002, and the correction coefficient with formula (2) becomes

$$K = 1{\cdot}000038\,;$$

while introducing $r = 250$ $L = 0{\cdot}02$,
directly $r' = 5$ $L' = 20$

into Prof. Ayrton's formula would give

$$K = 127.$$

Now, only figure 10,000 volts in a wretched resistance box of 250 ohms ! L = 0·02 is indicated in the pamphlet only to illustrate the calculus there made ; while 0·0002 is about the self-induction of a movable wattmeter coil of fifty turns of wire, enclosing about 60 sq. cm.

Well-made transformers run on open secondary circuits will make the current in the primary to lag about 50 to 70° behind the phase of the impressed E.M.F. In measuring the power supplied under such conditions with a wattmeter only a very small error will be incurred. I usually determine the energy consumed in the iron core of a transformer by supplying current to the secondary circuit, say at 100 volts.

Then $r = 1000$, and usually $2\,n = 100$,
$\tan \lambda = 0{\cdot}0000628$ $\tan \lambda'$ about 2,
$K = 1{\cdot}00013$.

I am satisfied by these and other considerations that in no case in which I have used the wattmeter, or have advised others to use it, did the error due to the actions in view come near to 1 per cent. of the power measured. The introduction of the true values of r' and L′ in Prof. Ayrton's original formula in cases where this is not admissible, and the assumption of conditions so unfavourable to the wattmeter as will not be realised in practice, explain how very large "correction" coefficients may be obtained.

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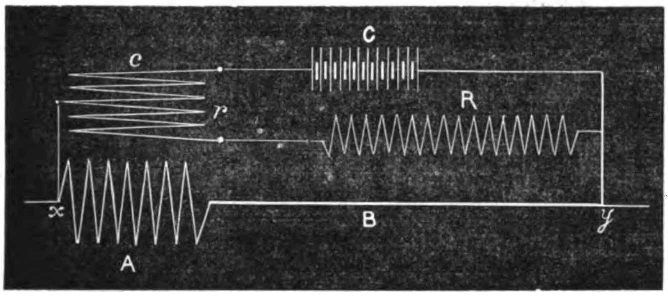
Should it be intended to use a wattmeter in cases where either λ' is very near 90°, or when a comparatively small resistance in the fine-wire circuit must be used, it would be easy to have instruments made with a large number of ampere-turns in the fixed coil and a smaller number of convolutions in the movable fine-wire coil, whereby the self-induction of this latter may be still considerably reduced, and a much wider scope of application given to the instrument.

An absolutely correct wattmeter can be made by putting two fine wires on the movable coil, the one connected up in the ordinary way in series with a non-inductive resistance, while the second fine wire is traversed by the charging and discharging current of a condenser acted upon by the same difference of potential as the fine wire resistance-circuit. This condenser circuit may also, besides the condenser and coil, contain additional resistances.



A thick wire coil of wattmeter,
B power consuming circuit,
r resistance fine-wire coil of wattmeter,
c condenser " " "
R non-inductive resistance,
C condenser.

It should be noted that the two fine-wire coils are connected up in inverse directions.

Now let i_1 be the current in r, and i_2 in c, then i_1 will lag a small angle behind the base of E.M.F., and i_2 will lag nearly 90°.

The reading of the wattmeter will be proportional to

$$\frac{1}{t}\int i\,(i_1 - i_2)\,d\,t,$$

i being the current in fixed thick-wire coil. To make the reading an exact measure of the power supplied to the thick-wire circuit, we must make $(i_1 - i_2)$ to have its phases synchronous with the phase of E.M.F. acting between λ and y. Supposing the two fine-wire coils to have equal numbers of turns in identical positions, the self-induction coefficient, as well as that of mutual induction, being L, the resistances of "condenser" and "resistance" coil circuits being also equal and r, then the capacity of the condenser should be

$$C = \frac{L}{r^2}$$

to satisfy the condition required for the instrument being a true wattmeter.

The constant of the instrument, however, will require a correction by

$$1 + \left(\frac{2\,n\,\pi\,L}{r}\right)^2,$$

which, for all practical purposes, is not worth consideration.

I hope, Sir, you will not consider this letter too long for your valuable paper, since it treats a matter of general interest, and will, I hope, assign to the wattmeter its deserved place in the list of scientific measuring instruments.—Yours, &c.,

OTTO T. BLÁTHY.

Albergo Milano, Rome, March 26, 1888.

P.S.—As you will easily see, there are some misprints in the transformed formulæ on page 506; K should there also be 127.

[It may be as well to add that the responsibility for the alegebraical error referred to in our correspondent's postscript (and also by Mr. Wilberforce) rests with the writer of the review, and does not in any way affect Prof. Ayrton's formulæ.—ED. *E.*]

THE FIRST USE OF ACCUMULATORS FOR ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In *The Electrician* of 17th February last, in the reproduction of Mr. Wm. Geipel's paper, read before the Institution of Mechanical Engineers, occurs this passage (speaking of accumulators as applied to electric traction):—"The problem was first attempted by Mr. Reckenzaun."

It is in no spirit grudging praise to a fellow-worker that I write this; those of us who have been pioneers in electrical locomotion can well afford to be accurate in the history of the various events forming historical epochs. Mr. Geipel has made a mistake. So far as this country is concerned, the first electric street car work was done at the beginning of 1882 on the North Metropolitan Tramways, under arrangements with that company made by me, and under my supervision. Some very important points were then ascertained in connection with accumulators on street cars.

Reference to these trials was made in the press early in March, 1882.

It was in the spring of the year following that the Electrical Power Storage car was operated at Kew.

But before even 1882—*i.e.*, in 1881—M. Philippart on the Continent had had cars running. No one conversant with the events succeeding the advent of the Faure accumulator can forget how much both accumulators, and consequently traction, owe to M. Philippart's energy and foresight. The first car run in this country was built abroad, and due to his work.—Yours, &c., RADCLIFFE WARD.

London, April 3, 1888.

THE SALE OF TELEPHONES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As certain dealers in electro-magnetic telephones are utilising the newspaper reports of the recent case "The United Telephone Company *v.* The Equitable Telephone Association," as a means of pushing their business, pointing out that their instruments employ no *carbon*, while it is the *carbon* transmitter of the Equitable Telephone Association that is being specially attacked, it is well that the public should be informed that these said newspaper reports are in this case—as is frequent when the daily papers attempt to handle scientific matters—calculated to give very erroneous impressions.

As a matter of fact, the United Company are attacking the receiver used by the Equitable Telephone Association quite as much as the transmitter, and if their contentions can be upheld, all the "membrane" telephones now in the market are equally infringements.—Yours, &c. A. A. CAMPBELL SWINTON.

75, Queen Victoria-street, London, E.C.,
April 3rd, 1888.

THE O'KEENAN BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having read in your estimable paper what you say about my battery, will you kindly allow me to submit a few observations?

1st. As to cost of light. I have never given any figures, following my friend, M. Hospitalier's, advice not to do so, as inventors' tests are always thought to be "*sujets à caution.*" The only thing I may say is that the sulphate of copper battery is acknowledged by all electricians to be *the most economical of all.*

2nd. My battery is not, as said by the paper you mention, a portable one, as it generally weighs over half a ton.

3rd. I have never been consulted about the publication of the note in the "important provincial journal" you speak of.

4th. Up to the present time I have not seen one single English capitalist.

5th. I regret that you have not heard of my battery before; it has been described here in several electrical papers:—*L'Electricien*, 1st January and 3rd September, 1887, by M.

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Hospitalier; *La Lumière Electrique*, 12th February and 19th November, 1887, by M. Marinovitch; *La Nature*, 27th August, 1887, by M. Hospitalier; *Journal des Arts et Manufactures*, by M. Delattre; *Bulletin International de l'Electricité*, &c. I take the opportunity of sending you the technical and practical description of my battery, written by me some months ago for Messrs. Mors, 8, Avenue de l'Opéra, my builders for France. These gentlemen have already, at their own expense and risk, made several installations of the O'Keenan battery, which give full satisfaction, having now been at work above six months, giving *regularly* when wanted *all* the light *required*.

We have in my father's house in St. Cloud a battery allowing us to have about 30 electric lamps, from 4 to 50 candle-power, in sitting room, dining room, bed rooms, stables, &c. The electricity produced by the battery is stored in twelve accumulators of 120 ampere-hours.

I would esteem it a favour if you would kindly publish these few lines in your largely circulated paper.—Yours, &c.,

C. ED. O'KEENAN.

St. Cloud, Paris, 31st March, 1888.

[Our correspondent does not enclose the description of the battery referred to. We should be pleased to receive it.—ED. *E.*]

FIRE OFFICE RULES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is whispered that the proposed new rules of the Society of Telegraph-Engineers and Electricians relating to electric light installations may not be materially different from those of the Phœnix Fire Office; if so, what possible purpose can their promulgation serve?

Moreover, the Phœnix rules are *copyright*, and there may be something to say on that score presently.

Will anything be gained by attempting to establish a kind of dual control? On the contrary, will not the beneficial effect of the moral sway hitherto exerted be seriously weakened or altogether destroyed? There has been a certain safeguard to the public in the fact that contractors have generally evinced a readiness to conform to the Phœnix rules, and as a natural consequence the class of work has been steadily improving, and the "cutting" firms have been finding it increasingly difficult to oust the truly conscientious contractors. If users of the light discover that there is need (real or imaginary) of a rival set of regulations, the growing confidence in this branch of electrical engineering will be shaken. If there be any necessity for revision or for enlarging the scope of the Phœnix rules, would it not have been possible to arrange a meeting of *representative electrical contractors* (upon whom the due execution of important works must fall, and not, I say it with all respect, upon the *consulting electricians*), at which Mr. Musgrave Heaphy, whose enthusiasm is admitted and to whom belongs the credit of compiling the Phœnix rules and bringing them in successive editions to their now complete form, might be present and conclusions arrived at satisfactory to all the parties concerned?

It is to be hoped that the members of the profession will insist that an independent committee be appointed by the Society to investigate and report upon the facts of this unfortunate dissension, and that such committee may invite Mr. Heaphy to give evidence and produce any correspondence that may have passed between himself and the Council of the Society on the subject, which is of the utmost importance and merits careful investigation.

It is perhaps a question whether the Council possesses the right to act in this matter without consulting the main body of members of the Society, and one thing is certain, viz., that scarcely a month will ever pass without the point involved being raised in some form or other, so that a settlement ought to be effected forthwith.

What we really need now is an efficient leader, and any one possessing the requisite qualities who will come forward at this juncture will earn the lasting gratitude of the whole profession.—Yours, &c., CONTRACTOR No. 3.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

4,453. J. SHAKESHAFT. Towcester. Improvements in railway signalling, which he names "Shakeshaft's automatic electric railway signal." March 23, 1888.

4,456. A. COLLINGRIDGE. London. An improved method of administering galvanic currents for curative purposes. March 23, 1888.

4,475. B. DUKES. London. Improvements in structures for supporting electric and other conduits, and for facilitating access to buildings (M. J. Hart, United States). March 23, 1888.

4,489. E. F. H. H. LAUCKERT and E. H. HAENSEL. London. An improvement in holders for electrical glow lamps. March 23, 1888.

4,523. J. KELMAN. Manchester. Telegraphic and telephonic apparatus, part being applicable to other electrical purposes. March 24, 1888.

4,524. W. J. S. BARBER-STARKEY. Manchester. Improvements in portable galvanic batteries. March 24, 1888.

4,559. F. DE WOLFFERS. London. Improvements in electric arc lamps. March 24, 1888.

4,561. C. A. BROWN. London. An improved battery jar. March 24, 1888.

4,568. S. WILLIAMS. Newport. Improvements in or relating to conductors for electrical and acoustic purposes. March 26, 1888.

4,579. J. J. DILLON. Dublin. A new or improved electrical apparatus for combining an electrical alarum with the ordinary mechanical alarum. March 26, 1888.

4,593. F. L. RAWSON and W. WHITE. London. Improvements in electrical batteries and methods of closing the same. March 26, 1888.

4,604. L. S. M. PYKE and H. T. BARNETT. London. Improvements in automatic apparatus for the continuous opening and closing of electric circuits. March 26, 1888.

4,626. C. HOEPFNER. London. Improvements in the electrolytic production of metals. March 26, 1888.

4,627. C. WELLS and F. J. GOAD. London. An improved method of using incandescent electric lights. March 26, 1888.

4,659. F. T. SCHMIDT. Bradford. Improvements in apparatus for making and breaking electrical circuits in connection with call or alarm boxes and recording the same automatically on dials. March 27, 1888.

4,673 P. M. JUSTICE. London. Improvements in and connected with apparatus for the generation and utilization of electric currents (C. Heisler, United States). March 27, 1888.

4,730. G. VENABLES. London. An electro-magnetic timepiece. March 28, 1888.

4,764. A. L. FRY. London. Improvements in portable galvanic and electro-magnetic batteries for medical purposes. March 28, 1888.

4,774. R. EISENMANN. Prussia. An electro-magnetic mechanism for pianos to strengthen and lengthen the sound of single notes, and to imitate the sound of other instruments. March 28, 1888.

4,804. E. J. PIPER. Northiam. A new switching arrangement for electric signalling, telephones, telegraphs, &c., by means of which any number of instruments may be worked on one single line one with the other. March 29, 1888.

4,819. W. G. JOHNSON. London. Battery for general electro-medical use, or as electrical dumbbells, Indian clubs, and the like for muscular exercise with electrical current of any desired strength during such exercise. March 29, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

March 31, 1888.

4,220. J. W. KING, London. Improvements in instruments for measuring electric currents March 21, 1887.

4,447. P. B. ELWELL, Manchester. A new or improved apparatus for measuring, indicating and recording currents of electricity. March 25, 1887.

4,832. H. LIEPMANN, of the Liepmann Carbon Co. (Limited), London. Improvements in the manufacture and construction of carbon plates or electrodes for use in primary batteries, and for electro-metallurgical, electrolytical, and other electrical purposes. March 31, 1887.

3,097. B. M. DRAKE and J. M. GORHAM, London. An improvement in holding the plates of secondary voltaic batteries. February 29, 1888.

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PATENTS SEALED.

March 29, 1888.

563. H. H. LEIGH. London. An improved dynamo-electric machine (J. L. Clerc Paris). January 13, 1887.

701. S. ZIANI DE FERRANTI. London. Improvements in electrical meters. January 15, 1887.

702. S. ZIANI DE FERRANTI. London. Improvements in dynamo electrical machines. January 15, 1887.

717. W. B. SAYERS. London. Disc dynamo-electric machines and motors. January 17, 1887.

800. J. B. WILLIS. Portsmouth. Improvements in electric telegraph apparatus, suitable for use to communicate between the bridge and the engine room of a steam ship, and applicable also to other uses. January 18, 1887.

831. M. IMMISCH. London. Apparatus for converting alternating currents into continuous ones. January 19, 1887.

2,959. H. C. COCQUEEL. London. A new or improved combined bell-push and automatic switch for electric alarms. February 25, 1887.

3,605. C. SELDEN. United States. Improvements in simultaneous telegraphy and telephony. March 9, 1887.

3,878. H. BOARDMAN. Manningham. Improvements in or connected with electric alarm clocks. March 16, 1887.

3,943. W. H. DOUGLAS. Stourbridge. Improved instruments for measuring electric currents. March 16, 1887.

4,138. A. C. COCKBURN. London. Improvements in safety devices in electric circuits. March 19, 1887.

8,329. W. E. LANGDON. Derby. Improvements in electrical signalling apparatus for railways. June 10, 1887.

11,923. C. L. R. E. MENGES. Netherlands. Improvements relating to the manufacture of plates or electrodes for primary or secondary electric batteries, and to apparatus therefor. February 19, 1887.

14,768. C. M. DORMAN and R. A. SMITH. Improvements in the construction of switches for the making and breaking of circuits conveying electric currents. October 31, 1887.

16,351. A. OWEN. United States. Improvements in electric belts. November 28, 1887.

17,157. H. H. LAKE. London. Improvements in galvanic batteries (J. O. Whitten, United States). December 13, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

3,158, 1887.—P. EVERITT. Giving currents of electricity for coin, &c. (Price 8d.)

5,140, 1887.—W. H. QUARTERMAN. Galvanic batteries. (Price 8d.)

5,193, 1887.—G. A. GRINDLE. Generating, &c., electricity. (Price 8d.)

6,267, 1887.—A. C. and THOMAS E. COCKBURN. Lock switches for electric circuits. (Price 8d.)

6,590, 1887.—W. H. SCOTT and E. A. PARIS. Magneto-electric cut-out. (Price 8d.)

6,933, 1887.—D. NICOLL. Insulating and laying electrical conductors, &c. (Price 8d.)

9,515, 1887.—E. WORMS and J. BALE. Tanning by electricity. (Price 8d.)

13,148, 1887.—F. ROSS and A. FRANZEN. Producing rectilinear or rotary motion by electricity. (Price 6d.)

13,447, 1887.—A. L. LINEFF and E. H. BAYLEY. Electric railways and tramways. (Price 1s. 3d.)

155, 1888.—A. J. BOULT. Eholing. Electrical turnstiles. (Price 8d.)

COMPANIES' REPORTS.

The Telephone Company of Ireland (Limited).

Report of the Directors, to be presented at the ninth ordinary general meeting, to be held at the offices of the Company, Commercial-buildings, Dame-street, Dublin, on the 9th inst., at twelve o'clock :—

The number of wires, exchange and private, under rental within the Dublin district and suburbs upon 31st December, 1886, was 915. On 31st December, 1887, the number was 936, being a net increase of twenty-one for the year.

The amount standing to the credit of net revenue account, including the balance of £329. 1s. 5d. brought from last account, amounts to £4,314. 3s. 6d., against £3,629. 2s. 4d. for the year 1886. Out of this sum there has been paid the interim dividend upon the preference shares for the half year ended 30th June, 1887 (£858. 19s. 1d. paid in July last), also the interim dividend upon the ordinary shares (£656. 5s. paid in August), leaving an available balance of £2,798. 19s. 5d., as shown in the balance-sheet, since reduced by payment (on the 14th January) of the dividend upon the preference shares for the second half of the year to £1,858. 6s. 8d., which the Directors propose to allocate as follows :—For the payment of a dividend on the ordinary shares for the second half of the year, at the rate of 1¼ per cent. per annum (absorbing £1,093. 15s.), against ¾ per cent. for the corresponding half of 1886, and equivalent to a distribution of 1 per cent. for the entire year, against ¾ per cent. for the year 1886, and to place to the credit of the reserve fund £398. 10s. 3d. (being 10 per cent. upon the net profits of the year), carrying forward the balance of £366. 1s. 5d. to credit of the current year, as against £329. 1s. 5d. brought in from 1886. In conformity with the Articles of Association, Mr. Hermann G. Erichsen and Alderman James Winstanley retire at this meeting, but being eligible, they offer themselves for re-election.

The auditor, Mr. John M. Kean, also retires at this meeting, but offers himself for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended March 30th, 1888, amounted to £4,315.

DIRECT SPANISH TELEGRAPH COMPANY.—Estimated traffic receipts for the month of March, 1888, £1,900, against £1,863 in the corresponding period of last year.

SUBMARINE CABLES TRUST.—The coupons of this Trust which became due on October 15th, 1887, will be paid in full on and after the 16th inst. by Messrs. Glyn, Mills and Co., of Lombard-street, between 10 a.m. and 2 p.m. Certificate holders are requested to present the October coupons only, and not those payable on April 15th.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended March 30th, 1888, after deducting the "fifth" of the gross receipts payable to the London-Platino-Brazilian Telegraph Company (Limited), were £3,491.

THE WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended March 31st, 1888, amounted to £4,175.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—Estimated traffic receipts for the half-month to March 31st, 1888, £3,703, as against £3,430 last year. December receipts, estimated at £5,577, realised £5,612.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, April 4, 1888.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending April 4, 1888. Highest.	Lowest.
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	39½ 40½	3 10 6	Jan., Apr., July, Oct.	..	...
2,614,820	Stock	20/0	Do. Preferred	66 67	4 5 3	" "	65⅝	...
2,614,820	Stock	nil.	Do. Deferred	14 15	...	February	14⅝	...
130,000	£10	3/0	Brazilian Submarine ...xd	12⅛ 12⅜	5 14 6	Mar., June, Oct., Dec.	12 5/16	12⅛
16,000	10	8/0	Cuba Submarine	12½ 13	6 3 2	February and August	13	...
6,000	10	10/0	Do. Preference	18½ 19½	5 2 6	" "	...	...
12,931	5	2½%	Direct Spanish (£4 paid) ...xd	3¾ 4¼	...	March & September	..	...
6,000	5	5/0	Do. Preference ...xd	8½ 9½	5 5 3	April and October ...	...	...
60,710	20	2/0	Direct United States ...xd	8¾ 9	4 11 6	Jan., Apr., July, Oct.	8 13/16	8¾
380,000	10	2/6	Eastern	11⅝ 11⅞	4 13 9	" "	11⅝	11 11/16
70,000	10	3/0	Do. 6 per Cent. Preference	15 15½	3 18 0	" "	15⅜	15 3/16
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	...	...
250,000	10	5/6	Eastern Extension	12¾ 13	4 14 3	Jan., Apr., July, Oct.	13	12⅝
22,050	10	5/9	German Union Telegraph and Trust ...xd	9 9½	6 3 3	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅞ 6⅛	4 18 0	Jan., Apr., July, Oct.	6⅛	6
178,992	10	3/0	Do. 6 per Cent Preference	13⅞ 14⅛	4 5 8	" "	14⅛	13 15/16
150,000	10	5/0	Great Northern	14¼ 14¾	5 5 6	Jan., July, and April	14½	14¼
17,000	25	5%	Indo-European	38 40	6 5 0	April and October ...	...	...
38,348	10	3%	London Platino Brazilian	5¼ 5¾	5 4 4	May and November	5½	5⅜
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October ...	...	...
338,225	Stock	15½%	Submarine	140 150	9 3 4	February & August	143	142
30,000	10	6/0	West Coast of America	5¼ 5¾	8 13 9	January and July ...	...	...
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88,321	10	nil.	West India and Panama	¾ 1	...	...	...	...
34,563	10	9/0	Do. 1st Preference	10¼ 10¾	6 19 6	April and October ...	10½	...
45,181	15	3/9	Western Brazilian	9¾ 10	7 2 6	March & September	10	9 13/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅝ ¾	5 9 0	Yearly	..	...
220,000	£1	...	Oriental (11s. paid)	5/16 7/16	...	...	...	...
80,000	5	5/0	United	14¾ 15¼	4 11 3	June and December	15 5/16	14⅞
50,000	5	2/6	United River Plate	4¾ 5¼	...	April and October ...	4 13/16	...
			ELECTRIC LIGHT.					
24,357	5	½ Feb., '86	Anglo-American Brush (£4 paid)	2¾ 3¼	...	...	...	...
28,692	5	2/0 "	Do. (fully paid)	3¾ 4¼	...	February & August	4⅛	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2½	...	...	2⅜	2 5/16
312,000	¼	5% '86	Maxim-Weston	1/16 3/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	6 1 3	March and July	39¾	39½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	15 17	5 17 8	February & August	16¾	16⅛

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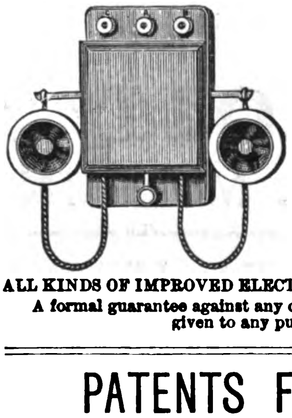

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 517.—Vol. XX. FRIDAY, APRIL 13, 1888. Price 4d.

NOTES.

We print elsewhere the full text of the "Rules and Regulations for the Prevention of Fire Risks arising from Electric Lighting, issued by the Society of Telegraph-Engineers and Electricians." It will probably be admitted by everyone that these rules are in themselves entirely acceptable —and yet it is difficult to see in what way their publication carries us any further forward, unless and until the Fire Insurance Companies also agree to abide by them. Meanwhile, the Society preserves its *amour propre* by the declaration that "it is to be understood that these general rules are not intended to supersede any detailed rules which Fire Offices may issue for their own protection." Just so; but is it not therefore obvious to ask *Cui bono?*

Coming to details we very soon find the inevitable permissive clauses, to which such strong—but as we think foolish—objection has been taken. In Rule 2 we read "The conductors, or their casings, should be placed in sight *if possible* [the italics are our own], and they should always be as accessible as circumstances will permit." In Rule 5 we read of "some suitable material," Rule 6 says that "special precautions must be taken," Rule 7 requires that conductors be kept "as far apart as circumstances will permit," Rules 8, 10 and 13 refer to certain undefined precautions—we need not further multiply instances. But this kind of thing is, as we have already remarked, simply inevitable, and does not militate at all against the value of the rules as such. But what it does conclusively prove is that some discretionary power must necessarily be vested in the Inspector. Who otherwise is to decide in any given case whether the "special precautions" are effective, or what is a "suitable material," or whether better arrangements are or are not "possible"? Contractors will do well to recognise these obvious facts at once; but whether or not any improvement can be effected in the methods of inspection or the qualifications of Inspectors is a question which requires consideration, but upon which we do not now propose to enter.

We have received from Mr. P. Delany, the inventor of the multiplex system of telegraphy now in use in the English Postal Telegraphs, a very lengthy communication which we hope shortly to have room to insert. We may here mention that Mr. Delany feels constrained to reply to certain statements and criticisms which have appeared in this country by or on behalf of M. La Cour, who claims to have discovered the principle of synchronism upon which the Delany multiplex system is based. These claims have already been fully and carefully investigated by a committee of the Franklin Institute, who have published an elaborate report upon the subject, accompanied by a number of letters from Danish, French, and German officials who have examined and reported upon the original work of La Cour. Their report has never been published *in full* in this country; if it had been Mr. Delany says he should not have thought it necessary to add anything in his own defence. We do not pretend to be fully acquainted with the whole of the details of this elaborate controversy; but, speaking from recollection only, the impression left upon our minds after reading the Franklin Institute report was that La Cour and Delany occupied positions jointly and severally analogous to those of Phillip Reis and Graham Bell—that is to say, La Cour undeniably had early possession of the idea that multiplex telegraphy was possible by means of some device for maintaining synchronism, and he worked in the right direction in trying to *maintain* synchronism by means of the so-called phonic wheel. Where La Cour failed—as it seems certain he did fail—and where Delany succeeded was in *obtaining* synchronism to start with, and in automatically *re-obtaining* synchronism whenever it was in any degree departed from. We have no desire to take part ourselves in this controversy either on one side or the other, but we are under the impression that the above statement describes the essential features of the case.

It may not be generally known that Mr. Crookes' very beautiful discovery of the "radiometer" has received a practical application in photography, for which purpose it is used in France in order to time the exposure of plates. By counting the revolutions of the radiometer it is evident that exposures of the same value may be obtained, under different degrees of illumination, with far greater accuracy than by depending upon the judgment of the operator. But in this country, where "instantaneous" plates have almost superseded the older methods, the radiometer has not, so far as we are aware, been employed for this purpose. In another column, however, we describe a most interesting development of the instrument due to M. Louis Oliver—to whom also is due the suggestion above described for its use in photography. M. Oliver has succeeded (it need hardly be said by aid of electricity) in causing the radiometer to produce a record of the number of its revolutions in a given time. This is, we believe, the first instrumental method of integrating the amount of luminous vibration falling on a given space, with

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regard both to duration and intensity, and its introduction will probably tend to stimulate investigation in a field which has as yet been little explored.

ANYONE wishing to know the potential capabilities of telephonic enterprise should read our American correspondent's letter this week describing the progress that has been made in that country by the Bell Telephone Company. The exchanges of this company alone employ no fewer than 6,182 persons, and its subscribers number 158,732. Its long-distance service is being rapidly developed, the pole mileage already amounting 550 miles and the wiring to 10,000 miles. These trunk lines are spoken of as a success both electrically and commercially; and the Western Union Telegraph Company is beginning to regard them as a serious competitor—at all events to the private lines belonging to that company.

NOTWITHSTANDING these signs of prosperity, the shares of the Bell Telephone Company have been subject to sudden vicissitudes owing to the ticklish position of its patent rights. These rights, however, were firmly established by the recent decision of the Supreme Court, and it is simply amazing that the death of the Chief Justice, who drew up the judgment, should cause quotations to fall from $260 to $245. Gamblers, however, are proverbially superstitious, and it may be that some sinister omen unfavourable to the Bell interests was perceived in the sudden death of a learned judge who had just pronounced in their favour. If that be the explanation, American speculators may take fresh alarm if they hear of the "remarkable coincidence" to which a London electrical contemporary drew attention last week. We were told that in both the recent American case and the similar English case in 1882 the delivery of judgment was signalised by the death of the presiding judge *a few days after.* This is very alarming, if true; and if taken in the Voltairian sense, "*pour encourager les autres,*" might have serious consequences for the friends of the Bell patent.

BUT it is not exactly true; or, to put it more politely, the coincidence does not coincide. The judgment on appeal in the English case—which, by the bye, was delivered in 1883, not in 1882—was, indeed, followed by the death of Sir GEORGE JESSEL, who presided; but not until six weeks afterwards, the dates being respectively February 6 and March 21, 1883. To a certain class of mind these facts may be reassuring; and as touching the depression of American Telephone Stock in consequence of the death of Mr. Justice WAITE, if we are to imagine that the personality of a judge has anything to do with the legal decision he will pronounce, our own feeling would be one of congratulation that he lived long enough to pronounce in our favour.

Mr. ALBERT CAMPBELL has hit upon a very simple and, as he says, "a wonderfully accurate" method of timing deflection readings which are undergoing more or less rapid changes. We merely mention it in this place thinking that it may sometimes prove useful in laboratory experiments—a full account will be found further on in a notice of the last volume of the *Proceedings* of the Royal Society of Edinburgh. It requires, however, the aid of about ten different observers, which may sometimes prove a difficulty.

THE battle of the transformers is by no means yet at an end, nor can victory as yet be said to incline to either side. Indeed, it is not to be anticipated that any decisive advantage will be obtained in a merely wordy warfare of this kind, especially when, as in the present case, each of the contending parties is able to bring to bear so many distinctive features of merit on his own behalf, and can so easily and so comfortably ignore those adduced by his opponents. In this country Mr. CROMPTON has once again entered the field on behalf of his highly prized (we trust the compositor will notice that we write z, not c) accumulators; although, at the time of writing, the blow has not yet been struck. In a Paper read before the Electric Club of Chicago (which we hope shortly to give), Mr. SLATTERY endeavours to parry the attack of Mr. LEONARD, who, as our readers are aware, has presented himself as a champion of the three-wire system. By means of extracts from the authorised publications of the Edison Company Mr. SLATTERY attempts—with some success, as it seems to us—to confute his adversary, as it were, from his own mouth.

MEANWHILE, on this side of the water, a fourth combatant enters the lists in the person of Mr. PERCY SELLON, who this week appears in our own columns on behalf of the motor-generator. In his preliminary paper Mr. SELLON sets forth, with much vigour and not a little dialectic skill, the claims of this system of distribution. We are for several reasons glad to welcome a diversion of this character, for whatever may be the outcome, it will scarcely be denied that this highly interesting system has not hitherto received the attention it deserves. Comparatively little has yet been written on the subject—though by far the greater part has so far appeared in our own columns. Mr. SELLON will perforce labour under the disadvantage of advocating a system which has not yet received a practical application; but, on the other hand, he is not called upon to explain away any disastrous failures. It is true that EDISON has in progress, or has been reported to have in progress, an installation of this character at Llewellyn Park, but since the first announcement nothing further has appeared in the American journals. We hope shortly, however, to obtain some definite information from our correspondent in New York.

AFTER all, it is a pity that, in this country at any rate, the discussion is so much "in the air." A few definite figures obtained from a comparison, not of one, but of half-a-dozen different installations of each kind, would be worth a hundred columns of argument and estimates based upon assumptions which the opposing side can and always does pronounce inadmissible or unfair. Detailed statements of expenditure, such, for instance, as those compiled by Mr. WRIGHT for the Brighton multiple-series installation, and which were published in *The Electrician* of 30th December, 1887 (p. 178), would afford data

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for really reliable conclusions. Possibly about the close of the century we shall be in a position to present such figures for the then surviving systems.

WITH reference to the convention entered into by the Chinese Telegraph Administration with the Eastern Extension and Great Northern Telegraph Companies, we are able to state that the particulars given in *The Times* on Monday last, and which we reprint in another coloumn, are substantially correct. The companies are to be congratulated on the completion of arrangements equally advantageous both to the foreign mercantile communities in China and to the companies themselves.

The Cost of Lighting the House of Commons.—Last year the cost of lighting the House of Commons amounted to £3,300 for gas, and £480 for electricity.

Bristol.—On Friday, June 8th, the oratorio of "Israel in Egypt" is to be given in the Cathedral at Bristol, and on this occasion the building will be lit throughout by electric light.

The Indo-European Telegraph Company.—It is announced that telegraphic communication with India, Turkey, &c., by the route of the Indo-European Telegraph Company, is restored.

Private House Lighting.—Messrs. B. Verity and Sons are electrically lighting "Mentmore," the residence of Lord Rosebery, and have also just completed the lighting of "Ascott House" for Leopold D. Rothschild, Esq.

Telegraph Extensions in Italy.—The Italian Minister of Public Works has authorised an expenditure of 139,000 lire (say £5,560) for the laying of a new direct telegraph line connecting Rome and Naples and Rome and Pisa.

The Patents of the Electrical Power Storage Company in France.—According to the *Bulletin Internationale de l'Electricité* the French patents of the Electrical Power Storage Company have been acquired by MM. Philippart Frères.

Tenders for the Lighting of Christchurch, New Zealand.—From a notice in another column, it will be seen that Christchurch, New Zealand, is following the recent example of Wellington in asking for tenders for electric lighting.

Edison's New Phonograph.—The first six samples of Edison's new form of phonograph will reach London in a few days, if they have not yet arrived. Colonel Gouraud proposes to present them to the principal crowned heads of Europe.

Inspector of Public Lighting.—We may call attention to the announcement in our advertising columns of a vacancy at Dublin for the post of inspector of public lighting to the Corporation, in which a knowledge of electricity is desired.

The Bray Electric Tramway.—An Order in Council is published in the *Dublin Gazette* authorising the construction of an electric tramway in Bray, from the Railway Station to the gate at the entrance to Bray Head, a distance of 1,500 yards.

Large Switch-Boards for Distribution Work.—We have been favoured with a view of the very large switch-board now being constructed by the United Electrical Engineering Company for the Aluminium Syndicate, and hope to give an illustrated description of it next week.

Army Signalling.—A school of instruction in army signalling for non-commissioned officers of Auxiliary and Volunteer Forces in the Home District, to be held Tuesdays, Thursdays, and Saturdays, from 6 to 8 p.m., will be commenced at the Signalling Office, Wellington Barracks, on Saturday, the 21st inst.

Electric Organ Keyboard.—The new concert organ which will contain some 3,500 speaking pipes for the Philharmonic Hall in Berlin is to be worked on an electro pneumatic system. There will be a movable keyboard, which will be connected to the instrument by a cable about 14 metres long, composed of 350 wires.

Carbons.—An American journal says:—"A new process of manufacturing electric light carbons or pencils and battery plates consists in decomposing natural gas under high heat and pressure, which gives a hard, very compact, and almost chemically pure carbon. It is then crushed, ground, and moulded in the usual way.

The Electro-Harmonic Society.—On Friday last this Society gave its concluding concert for the season; the programme was of the usual excellence. Mr. E. Graves, who occupied the chair, made a few felicitous observations, and concluded by proposing a vote of thanks to the musical directors, Messrs. Alabaster, Gatehouse and Thompson.

Tapping Telegraph Wires in France.—*La France* states that Count Dillon, managing director of the French Cable Company, has commenced an action against the *Matin* for robbery and divulgence of his private despatches. The *Matin* is said by some means to have secured and published the telegrams which passed between Count Dillon and General Boulanger.

Permanent Sample Room of British Products and Manufactures at Hamburg.—In connection with this excellent idea, a circular has been issued by the British Vice-Consul containing much information of interest to manufacturers. Applications for space for exhibits, or for copies of the circular, should be made to Mr. G. A. Pogson, British Vice-Consul, Colonnaden 104, Hamburg.

Church Lighting by Electricity.—The parish church of Blockley, a large village on the southern border of Worcestershire, is shortly to be lighted by electricity. The installation is being carried out by a company who have taken some old mills near at hand for manufacturing purposes, and the machinery will be driven by water power, of which there is an abundance available.

Norwich.—On Thursday evening last week a lecture was delivered by Prof. W. Barrett at Norwich "On Electric Power." The lecture was illustrated by numerous experiments, for some of which plant was lent by Messrs. Paris and Scott. It is needless to add that Prof. Barrett delivered a highly interesting and very lucid address, which was listened to with the utmost attention throughout.

Catalogue of Woodhouse and Rawson's Electric Supply Company.—The Woodhouse and Rawson Electric Supply Company have issued a second edition of their "Catalogue of Domestic Electrical Supplies," in which will be found quotations of retail prices of almost every conceivable requirement for the electrical fittings of a house, including electric bells in great variety, telephones, gas lighting apparatus and electric lighting.

Paris.—The French Minister of Finance has recently appointed a committee to study questions relating to the organisation of submarine telegraph systems. The chairman is the Director-General of the Postal and Telegraph Department. Amongst the members we notice the names of M. Ungeier, Head of the Central Office of the Postal and Telegraph De-

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partment; M. Amiot, Inspector-General of the Postal and Telegraph Department, and M. Bélugon, sub-engineer of the same department.

A Central Station for Cologne.—The Town Council of Cologne have come to terms with the promoters of the central station for the business quarter of the town. The station is to be arranged for 6,000 glow lamps, but is to be capable of being enlarged to 12,000. The tariff is to be ⅜d. per 16 candle-power lamp-hour, with a yearly minimum of 350 to 500 lamp-hours, according to circumstances. The capital is to be £62,500, which will in the first place be offered to the citizens, in order to promote an effective control of the operations by the shareholders.

Eastbourne.—The report of the Lighting and General Purposes Committee of the Eastbourne Town Council contained the following resolution:—"That the account of the Eastbourne Electric Light Company for lighting the Town Hall for three months ended 25th December last be referred to the borough surveyor to report upon, and that it be a recommendation to the Council to pay the Eastbourne Electric Light Company the sum of £50 without prejudice, in respect of the supply of electric light for the Town Hall for the six months ending the 25th ult."

The Lewis Telegraph Cable.—In the House of Commons, on Tuesday last, Dr. M'Donald asked the Postmaster-General when it was his intention to have the telegraph cable between Lewis and the mainland, which had been out of order for several weeks, repaired; and whether, having regard to the large fishing interests of the island, which were mainly dependent for the sale of fish on telegraphic intelligence, he intended to lay a new cable instead of that now out of order.—Mr. Raikes said, in reply, that the cable ship belonging to the Post Office is at the present moment engaged in the repair of the Stornoway cable.

Electro-Technical Education in Germany.—An attempt is being made by the Frankfort Physikalischen Verein to establish an electro-technical school under its auspices, and a Paper read before the society by Herr E. Hartmann explains the aims of the project. Its object is not to increase the number of the scientists and engineers, but simply to provide practical scientific training for artisans. The course is to be one or two half years, and there will be an annual special course at the end of each winter, lasting only two or three weeks, on lightning conductors. In connection with the school it is also proposed to have a testing laboratory, and later on one for private original work.

Electric Traction on the Brussels Tramways.—In reference to the statement made in the report of the Brussels Tramways Company, which we quoted last week, that electric traction by accumulators had not hitherto been a success upon their lines, we have received a copy of a circular issued by the directors of the Société Electrique, by whom the batteries were furnished, which tends to put the affair in a somewhat different light. Without entering fully into the facts, it will be sufficient to state that the electrical company complains that since the purchase of the batteries it has not been consulted by the tramway company in any single instance, nor has its advice been followed. It also traverses the method in which the figures showing the cost of traction are arrived at.

Sheffield Telephone Exchange.—On Thursday, the 5th inst., the number of messages through the Sheffield Telephone Exchange reached the unprecedented number of 10,450, exceeding that of the corresponding day in last year by 3,598. Although the exchange is open night and day, and almost every profession, trade and calling is represented, the bulk of the work is done in five hours, *i.e.*, between 10 and 12:30 a.m., and 3 and 5:30 p.m. During these hours the capacities of the attendants and switch-boards are mostly tested—some of the attendants putting in communication as many as 720 subscribers per hour. There was an average for that day of over 20 messages per subscriber, the cost being less than a farthing per message.

Exports of Telegraphic Wire, &c.—The Board of Trade returns for March, and for the three months ended March 31, again show a falling off both for the month and for the quarter in the value of our exports of wire and telegraphic apparatus. The following is a comparative statement of the exports in the first quarter of this and of the two previous years:—

Exports of Telegraphic Wires and Apparatus connected therewith.

	1886.	1887.	1888.
January	£68,623	£14,442	£41,231
February	19,286	44,137	14,051
March ...	36,165	73,300	32,795
3 Months	£124,074	£131,879	£88,077

Compound Telephone and Telegraph Wires.—An old idea, first tried in America some years ago, has been revived, says *Industries*, by Messrs. Kareis and Bondy, Vienna, who have patented iron or steel wires covered with a spiral serving of copper wire or ribbon of very small thickness. These wires are now being tested at the laboratory of the Electrotechnical Institute in Vienna, and have so far given fairly good results. The object of the invention is to provide aërial wires having less self-induction and resistance than ordinary iron or steel wires, without sensibly diminishing the mechanical strength. The wire is intended for use with currents of rapid period, such as occur in telephony or in high-speed telegraphy, and as through self-induction the flow of current is displaced from the centre to the circumference, the inventors argue that it would be useless to make the centre of a material having a high conductivity.

The Royal Institution.—The following is a syllabus of a course of six lectures on the Chemical Arts to be delivered by Prof. Dewar, M.A., F.R.S., on each Thursday afternoon, from April 12th to May 17th, inclusive, at three p.m.:—Present Position of the Leblanc Soda Manufacture and the Sulphuric Acid Industry.—Development of the Ammonia Soda Process of Alkali Production.—New Methods of making Chlorine, Bleaching Powder, and Chlorates.—The Strassfurt Salts and Nitrate Industry.—Utilisation of Distillation Products from Coal, Shale, Coke Ovens, and Iron Furnaces; Recovery of Sulphur from Alkali Waste; Uses of Iron Slags. —The Soap Industry; Glycerine; Glass Manufacture.—Industrial Uses of Compressed Gases; Organic Explosives; Oil and Water Gas; Petroleum as a Fuel; Lubricating Oils.—New Sodium Process; Electro-Metallurgy.—Electric Furnaces; Cowles' Aluminium Bronze Manufacture; Electric Welding; Bleaching and Treatment of Ores.—Production of Artificial Organic Compounds.

The Electric Lighting of the Vienna Opera House.—According to the Vienna correspondent of *Industries*, the Imperial Continental Gas Association are still experiencing some trouble in connection with their electric lighting installation in that city. Writing on the 3rd inst., he said:—"Some alterations are being made in the central station from which the Opera is supplied. When the steam dynamos were first erected, the

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vibration communicated through the walls to the adjoining buildings was so great that in some rooms it was impossible to write, and the owners of the property commenced legal proceedings, with the result that the Imperial Continental Gas Association was ordered to discontinue the nuisance on a penalty of 5,000fl. for each infringement of this order. To overcome the difficulty, the association have laid down an enormous foundation block of concrete, on which the dynamos are placed. This block is completely detached from the walls of the building, so that no vibration of any kind will be communicated to the neighbouring houses."

Central Station Work in Portugal.—The new central station of the Companhia de Luz Electrica, Oporto, was inaugurated on the eve of the 31st ult. This company has for some time past supplied a small number of lamps from five dynamos of various and antiquated patterns, and of English, French and German origin. The inferior construction of the machinery and general installation was the cause of irregular supply, and the company therefore intrusted Mr. F. Baerlein, of Rua da Prata 40, Lisbon, with the erection of entirely new plant and building. The inauguration took place with the customary festivities, and the general design of building, as well as machinery and plant, earned the highest praise from all present. The station is designed for an extreme capacity of 3,000 lamps, but only the first section is yet completed, the remainder being added with all possible speed. The installation presents considerable novelty in the general arrangements, most of which have been specially designed by Mr. F. Baerlein, and partly executed in England, partly in Lisbon.

A New Current Meter.—Prof. R. Bœrnstein, of Berlin, has devised a current meter of novel construction. It consists (1) of a dynamometer, whose indications are proportional to the current intensity; (2) a planimeter which integrates the deflections of the dynamometer. The axis of rotation of the movable bobbin is placed at an angle to the vertical, and the proportionality of the deflection is obtained by a very ingenious device. A sector is affixed to the axis, and is balanced by a small weight attached to a cord which runs over a couple of pulleys. The form of the sector is so adjusted that the movement of the weight is always proportional to $\sin a \tan a$, a being the angle of deflection; and it can be shown that under this condition the tangent of the angle of deflection will be directly proportional to the current. The rotation of the axis of the coil displaces a disc over which a wheel moves in such a manner that its velocity is proportional to the angular displacement of the disc. The number of turns made by the wheel is registered by a train of clockwork. The apparatus is evidently available either for continuous or for alternating currents.

Electric Lighting of Spanish Theatres.—As far back as the 18th November last we referred to the proposal to make the lighting of the Madrid theatres with electricity compulsory, and in our last issue we were able to state that definite terms had been published in the Madrid *Gazette*. Spanish papers to hand since bring details of the regulations, according to which we observe that installations must be completed within six months from 1st April. During the first three months licenses are to be applied for and prepared, and during the last three months installations and machinery must be completed. Theatrical managers may use a private light generated on the premises, or may take the light from companies which are already established, or which may be established in the future. Incandescent lights must be used in the interior of the theatres, with the exception of the stage, on which permission will be given to use the arc lamps in order to produce the effects of the Drummond light, now strictly prohibited. Outside the theatres the arc lamps may be used. As the use of gas is strictly prohibited, oil lamps (olive oil) may be used as supplementary to the electric light.

The Relative Cost of Gas, Oil, and Electricity in Russia.—Before imposing the recent duty of one copeck a pod on kerosine, the Russian Minister of Finance appointed a committee of experts to collect information as to the relative cost of gas, oil, and electricity in the two capitals, in order to determine whether the proposed tax would have an injurious effect on the petroleum industry. The data supplied, says *Engineering*, was of course very elaborate, as Russian official statistics always are; but without reproducing the details, we may say that, roughly, the price of gas and oil at St. Petersburg differs very slightly from that prevailing in London, while electricity is somewhat cheaper. Reckoning the price of kerosine at 1 copeck, the relative cost of other methods of lighting at St Petersburg was as follows:—Gas, 3 copecks; electricity, 7·3 copecks; and stearine candles, 22·9 copecks; while at Moscow the proportions were—gas, 6·2 copecks; electricity, 10·4 copecks; and stearine candles, 34·4 copecks. In this manner oil was three times cheaper than gas at St. Petersburg, and six times cheaper at Moscow. One can hardly wonder, therefore, at its gaining ground in both places.

Kensington Electric Lighting.—At the last meeting of the Kensington Vestry the Works Committee reported that, in compliance with the reference by the Board of the 10th ultimo they had considered the copy of the draft license by which it was proposed to authorise the Kensington Court Electric Lighting Company to construct and maintain electric lines and works, and to supply electricity within the parishes of St. Mary Abbotts, Kensington, and St. Margaret, Westminster, and, after conference with the engineer and the solicitor, had instructed the latter to suggest the following alterations to the Board of Trade:—In clause 7 (section C), authorising the carrying of the line over or across any street, the addition of the word "bridge." In clause 10, relating to interference with any sewer, drain, watercourse, defence, or similar work under the jurisdiction or control of the Board, the insertion of the words, "or work in connection with such sewer or drain, such as ventilating shafts, manholes, side entrances and gullies;" also a provision that any consent given by the Board should be in writing. The committee requested the sanction of the Board to the course they had taken. The report was approved.

Berlin.—The Khotinsky Company of Rotterdam have established a central station in Neue Friedrichstrasse, Berlin. Ten-year contracts are already entered into for six 1,000 candle-power arc lamps, 12 of 500 candle-power, and 550 16 candle-power 150-volt glow lamps. The plant at present consists of 45 horse-power boiler, 35 horse-power engine, a dynamo for 150 volts and 130 amperes, and a set of accumulators for 150 volts, and having a capacity of 600 ampere-hours. The capital, we understand, is to be £3,000, which is to allow for a second engine and boiler and foundations for another dynamo, the staff consisting of one engine driver and one stoker. The connections from the mains to the houses are made at the company's expense, and the current is measured by Aron's meter. A further addition of 300 glow lamps will shortly be made; the capital will then be increased by £500 to provide for the mains and second dynamo, while the staff will be increased by one whole boy. Any further extension will require a new cable and second battery equal in capacity to the present one, and, let us hope, another boy. The capital will then be increased to £5,000! We beg to state we are not responsible

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for these remarkable figures, but extract them from the *Elektrotechnische Zeitschrift.*

Football.—Cable Companies versus Channel Squadron.—A correspondent writes:—On Saturday, March 24th, a football match was played at the Eastern Telegraph Company's station, Carcavellos, Portugal, between a team selected from the staff there and a team composed of officers from the various vessels of the Channel Squadron, then anchored in the Tagus. The weather was unpropitious, the rain falling heavily during the whole contest, but it had no effect in damping the ardour of the players; and, although the ground soon became very heavy and slippery, the men seemed to gather fresh strength from their frequent contact with Mother Earth. A capital and exciting game was played, but, despite the gallant efforts of the staff team—of the forwards, Messrs. Spriggs and Wray specially distinguishing themselves—fortune inclined to the naval men, who scored seven tries to *nil.* This result, however, was scarcely to be wondered at, the team from the squadron being composed, without exception, of full-grown, heavy men, who contrived by their style of play to reap all the advantages conferred by their preponderance of weight. After removing the traces of the struggle, the teams adjourned to their dinner in the staff mess room, which was followed by a very enjoyable musical evening. Team as follows:—Freeman (back), Master (capt.), Hurtler and Morris (three-quarter backs), Fraser and Lyall (half-backs), Penrice, Wray, Spriggs, Dupuis, Lawson, Paine and Dowthwaite (forwards). Besides those mentioned above Mr. Hustler played well.

The Lighting of the Hotel Ponce de Leon, St. Augustine.—The Hotel Ponce de Leon, at St. Augustine, Florida, contains one of the largest isolated electrical plants in the world. It consists of four Babcock and Wilcox multitubular boilers working up to 107 horse-power nominal each, four Armington and Sims engines, three of 60 horse-power, and one of 125 horse-power. Each of the 60 horse-power engines drives a 640-light Edison dynamo, and the 125 horse-power engine drives two No. 16 Edison dynamos. The plant supplies some 5,500 incandescent lights in all, and "feeders" are employed as in the Edison method of distribution. In connection with this installation, the *Scientific American* says that Mr. Flagler is trying the experiment of obtaining motive power from an artesian well. The well throws up a column of water 35ft. high and 12in. in diameter. Directly over the well is a large turbine wheel; bolted directly to the shaft of this wheel is a 375-light Edison dynamo. As far as steadiness and constancy of the light are concerned, the trials have proved eminently satisfactory; but the power obtained has not been so great as was expected. This is chiefly due to the method in which the stand pipe is connected with the turbine, and to the arrangement of the paddles in the wheel, which allows a great proportion of the water to pass by. Changes are being made to remedy this, and it is then intended to run all night with the hydraulic plant alone. Contrary to the anticipations of experts, the flow of the water has remained constant for three months. The experiment is, we believe, the first of its kind on record.

Lighting of ss. "Paula."—The ss. "Paula," built for the petroleum trade by Sir W. G. Armstrong, Mitchell and Co., at Low Walker, has an installation of electric light by Rankin Kennedy, of Glasgow. The dynamo is one of Kennedy's single bobbin machines, capable of supplying 70 16 candle-power lamps, running at a speed of 750 revolutions per minute. The motive power is derived from a Tangye's "Archer" type vertical engine, and the dynamo is driven by means of a canvas gutta-percha belt from the fly-wheel. In the whole ship, with the exception of the saloon and officers' quarters, specially protected conductors, insulated with vulcanised india-rubber, and sheathed over all with galvanised iron wires, are used. The joints in these conductors are protected by specially designed malleable cast-iron joint-boxes, and the whole arrangement makes a very substantial job, calculated to withstand any amount of rough usage without injury. This is of the greatest importance in petroleum-carrying vessels, where the conductors require to be specially secure on account of the nature of the trade. The fittings in the saloon and cabins are of neat designs, in harmony with the other fittings of the ship. The globes are of pale pearl, and give a particularly pleasing tone to the light. Throughout the whole ship, wherever light is required, the electric light has been carried, and arrangements are also made, and portable lamps with long flexible leads provided, for carrying the light down into the tanks when they require cleaning out or inspecting. The masthead, side, and anchor lamps have also been arranged for electric light. We understand that the same firm are engaged fitting out the "Caucase," another vessel for the same trade (recently launched by the same builders), and they are putting electric light on two passenger steamers for the Chinese coasting trade, now building at Messrs. Hawthorn, Leslie and Co.'s.

Electric Light in Dublin.—The Corporation of the City of Dublin are advertising under the Electric Lighting Act, 1882, their intention to apply to the Board of Trade for authority to supply the city with electric light. They ask for liberty for this purpose "to open and break up streets and bridges, to alter the position of gas and water mains, pipes and wires, sewers and drains under the same; to acquire lands, to appropriate lands, to construct such works, acquire such licences, to enter into such contract, and to do all such acts and things as may be necessary and incidental to such supply." The proposed area of supply is the city without limitation of any district. The streets in which it is proposed to place electric lines are, to start with, Sackville-street Upper, Sackville-street Lower, O'Connell Bridge, D'Olier-street, College-street, College-green, Westmoreland-street, Grafton-street, Island Bridge-road, Sarah Bridge, Conyingham-road, Parkgate-street, Albert-quay, Sarsfield-quay, Ellis's-quay, Arran-quay, Inns-quay, Ormond-quay Upper, Ormond-quay Lower, Bachelor's-walk, Dame-street, Parliament-street, Grattan Bridge, Capel-street, Mary-street, and Henry street. These are specifically enumerated in the application, and in order to carry out the works the Corporation further desire to have liberty to break up the tramway lines through the city. The application for a licence, says the *Irish Times*, for the supply of electricity for public purposes raises the question of public lighting in a new and interesting form, and it is one to which the citizens are bound to give instant attention. Reference was made to the subject of lighting by the Lord Mayor in the speech on practical topics which he delivered at the High Sheriff's dinner. The allusion was direct enough. "Will you say, Mr. High Sheriff (said his lordship), that the condition of the public lighting of the City of Dublin is in such a condition in which it ought to remain? I appeal to the High Sheriff with confidence, because I am aware that no personal relation in which he stands can affect either the keenness of his intellect or in public affairs the impartiality of his judgment. I say that neither in regard to cost, nor the character nor the control, is the system of public lighting in Dublin satisfactory." Thus appealed to, the High Sheriff stated that, though a director of the gas company, he believes that the supplying of light to the city should be under municipal control.

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CONTINUOUS-CURRENT TRANSFORMATION.

BY R. PERCY SELLON.

At a time when electrical engineers, both in England and America, are anxiously discussing what system of electrical distribution is to be looked to as likely to fulfil the requirements of supply of electricity over large areas, it may be well to inquire into the latent possibilities of a system which has hitherto received but an intermittent kind of attention, and even that to a large extent with a sceptical incredulity—that of distribution by continuous-current transformers, or "motor-generators," as they are sometimes called.

The continuous-current transformer has really not yet been taken *au serieux.* Quite recently it was included among other possible systems of distribution, and figures adduced which showed it to compare unfavourably with distribution by alternating currents, yet not so unfavourably as that by means of secondary batteries, or "battery transformers." In spite of this, the conflict of opinion lies between alternating currents and batteries, and continuous-current transformation is left out in the cold.

It is intended in these articles to glance at the subject—

First: In respect to relative merits and disadvantages when compared with other systems.

Second: To survey the past history of the continuous-current transformer, touching upon patents and publications relating to it, up to date.

Third: To examine afresh its position from the practical standpoint, viz., that of initial cost.

The past ten years, within which period all commercial electric lighting, under whatever system, has been condensed, have witnessed successively the following developments:— First, series supply; second, multiple arc; third, series-multiple; fourth, secondary battery supply; fifth, alternate-current transformation.

Until but a few years ago—one might almost say a few months—the first four systems absorbed all the attention of electrical engineers.

Despite the earnest advocacy of "series" distribution by at least one well-known firm of manufacturers, electrical engineers have turned a deaf ear to this scheme as being likely to afford the true solution of the problem before them.

"Multiple arc" has had, and in all cases where the area of supply is limited and compact is likely to have, a long and successful innings. A visit to any town of reasonable magnitude in the United States will readily convince one that under the above conditions "multiple arc" distribution—mainly on the three-wire system—answers sufficiently well both technically and financially.

But, unfortunately, in this country, compact areas demanding electric light are not to be found. The "Britisher" does not build his houses so high nor adopt a good thing with the same avidity or unanimity as his American cousins. The conditions are, therefore, different.

"Series-multiple," as a method of extended distribution for domestic purposes, requires no comment.

Admittedly, therefore, there are left but three systems which may be regarded as able to fulfil the requirements of practical distribution over all areas. They are:—

(I.) Distribution by secondary batteries alone, acting as transformers.

(II.) By alternate current transformation.

(III.) By direct current transformation.

For the moment these may be compared with reference to their relative values in the following directions:—

(*a*) Adaptability to various demands: light, power, and storage.

(*b*) Reliability of operation.

(*c*) Efficiency.

(*d*) Freedom from danger to life.

Dealing first, then, with the system of secondary batteries used as transformers.

Secondary batteries can hardly yet be said to have been thoroughly put upon their trial for purposes of distribution. The installations at Colchester and the Vienna Opera have been the nearest approach to such a state of things, but the former, for well-known reasons, was short-lived, and the latter, though electrically successful in every way, only partially satisfies the conditions that must obtain in extended practice, inasmuch as the local centres of supply are few in number, and the charging current sensibly large compared with the demand from the batteries at each local centre.

Now, as regards the disposition of secondary batteries in any system of supply, it is evident that the scheme of distribution by their means from local centres must find favour with practical electrical engineers in preference to that of installing them upon each consumer's premises.

There are two difficulties which must be coped with in any complete system of battery transformation:—

First: In order to preserve the discharging low tension supply from the full tension of the primary current in case of leakage, charging and discharging should not be carried on concurrently.

This entails the use of two distinct sets of batteries.

Second: The conditions of charge being those of high E.M.F. and small current, and of discharge the reverse of these, the batteries must be charged in sets placed in series with one another, and such sets thrown into parallel for the discharge. This entails a considerable number of relatively small-sized batteries, and a consequent arrangement of more or less complex automatic devices.

These considerations, however, involve no insuperable difficulty of any kind, but simply involve the question of increased first cost arising out of multiplication of parts.

In respect to adaptability to the demands of both lighting and motive power, this system answers well; and in regard to reliability, absolute immunity from danger of extinction, and freedom from personal risk of shocks, leaves nothing to be desired.

Distribution by alternate-current transformation is having it very much its own way just now. It is the idol of the hour. Ushered into existence only comparatively a few months ago with incredulity and even derision on many sides, the tide of electro-public opinion has turned with prodigious rapidity, and lifted it upon a rock of great, apparently, for the moment, of impregnable strength.

The advantages of the system speak for themselves. The extreme simplicity of the apparatus for converting the initial high-tension primary current to one of low tension; the entire absence of moving or delicately organised parts requiring frequent attention; the perfect self-regulating properties of the transformers when placed in parallel; the high efficiency of conversion under certain conditions—all these constitute advantages which must at once recommend themselves to any practical electrical engineer.

But this system lacks two important properties which are to be looked for in any ideal system of distribution:—

(I.) The ability to store power;

(II.) Economical supply of motive power.

As regards the former, it is certain that, whether secondary batteries are advocated as the means of transformation, or only as an adjunct to low-tension supply obtained by other means, a system which admits of storage must, other things being equal, have unhesitating preference accorded to it.

That the application of motive power to a variety of purposes will promptly arise out of the ability to procure it must be carried home in the most convincing manner to any one who has seen, as it has been the writer's good fortune to do recently, the remarkable development in this direction attending the establishment of central stations in the United States. It is needless to say that this utilisation of plant during hours when it would otherwise be lying comparatively idle is a source of revenue of an important character; so much so, that, as the writer was informed upon the highest authority, it has frequently been the means of converting a loss on working to a substantial profit.

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Alternating-current motors cannot yet be said to be an accomplished fact. That the demand for them will create, and is in process of creating, a supply there is no reason to doubt. Nevertheless, where the conditions of operation are those of rapidly varying load or speed (as must frequently be the case in practice), it is difficult to anticipate an economical compliance with the demand.

"But," it is urged in favour of this system, "despite its shortcomings in the above directions, it possesses this unique feature which neither battery transformers nor continuous-current transformers can claim, that by its means electricity can be conveyed direct to each consumer's premises without the intermediary of local centres and the attendant outlay on land, buildings, distribution mains, and skilled attendance. It is therefore a system which can be put to work straight away, with a minimum of obstruction from Electric Lighting Acts, shilly-shallying Boards of Works, and vested-interest vestries." Granted. So long as the existing arrangement of overhead wires is permitted, this argument possesses great force. But this blissful state of things must be short-lived. The time cannot be far distant when all conductors will have to be placed underground ; and, as a matter of fact, it is more than probable that any electrical engineer contemplating the laying down of a system of alternate-current distribution would at this moment hesitate to provide for any but underground conductors.

Under the latter conditions it requires no prophetic eye to foresee that the initial outlay, the danger of general leakage, the risk of shocks despite all precautions, and the cost of maintenance, arising from a ramified system of conductors conveying high-tension currents to the door of each consumer, will probably be held to more than balance the disadvantages attendant on the establishment of local centres.

Assuming this, the balance of *pro* and *con.* for the three systems becomes largely readjusted. The factor of local centres and distribution mains—both heavy items in initial outlay—becomes common to all. It resolves itself, then, into a question for consideration between the high efficiency of conversion, the relatively smaller area required for plant, and consequently smaller local centres, and to some extent diminished skilled attention, belonging to the alternate system, on the one hand, as against the benefits arising out of greater security from use of storage, income derivable from supply of motive power, and diminished risk of leakage and shock which pertain to continuous-current supply, on the other.

The main objections raised against the continuous-current transformer resolve themselves into the following :—

First : that it is a piece of moving mechanism ; and this fact is not only fatal to its domestic adoption, but enables it to compare but ill with the stationary alternate converter.

Second : that it is a disproportionately high-priced article in contrast with the alternate converter, and will cost more to maintain.

Third : that its efficiency of conversion can never reach that of the latter.

Let us examine these objections :—

Firstly. Nobody will be so hardy as to dispute that our national education has not yet brought James or Abigail up to the point of being likely to view with any composure the diurnal lubrication or adjustment of a revolving dynamo wherein many hundred volts are urging on their wild career. There is no disguising this fact ; it means local centres for distribution.

But the opinion has already been expressed that, whatever the system employed, so long as high-tension currents—say, of 1,000 to 2,000 volts—are made use of, it will be expedient to distribute the low-tension supply from local centres ; and, once given local centres, it ceases to be a matter of primary importance whether the transformers are in motion or stationary. A local centre for 2,500 lights, obtained from continuous-current transformers, need not mean more than a cellar, 12ft. square ; and since the transformers are perfectly self-contained, the mechanical strains being all from within and not external, no elaborate precautions need be taken as to solidity of foundations or surrounding structure.

As to attendance, a single engineer would have no difficulty whatever in attending to the requirements of such a sub-station, even were the transformers built on the lines of our present dynamos—without any special precautions as to automatic lubrication and collection of current—and less attendance than this could hardly be provided under any system for supplying an equivalent capacity in electrical energy.

Secondly. As to the relative outlay requisite on the two different classes of transformer, it is obvious that if the continuous-current apparatus is built in accordance with the existing notions as to axial or peripheral speed holding in dynamo construction, its cost will be many times as high as that of the stationary alternate converter ; but the very fact that in the former all the strains are from within, removes any scruple to run them at far higher speeds than now obtain for dynamos, and thus bring the relative cost of the two classes of apparatus much more on to a par.

Obviously, this is only one of several difficulties to be met, and improvements to be effected, upon our present crude ideas of continuous-current transformers ; but the point is, that there is nothing inherently obstructive to their development in every direction to be desired, and this fact has only to be faced to produce a due result.

Thirdly. On the point of efficiency of the continuous-current transformer *per se*, there is no difficulty at the present moment in obtaining a commercial efficiency of over 90 per cent. As to the relative mean efficiency of the two complete systems in practice, including generating dynamos, conductors, and transformers, when working through the 24 hours on large variations of load from hour to hour, it is not a rash proposition to hazard that the continuous-current system would be found at the end of the day's work to have given a satisfactory account of itself.

More than one mind in this country is already busied with the development of the problem of which it has been attempted in these notes to point out some of the leading features, and at a period of rapid evolution of ideas like the present some practical outcome may be confidently looked for. In any case it is desirable to thresh out all that may be said on each side before settling down into a fixed groove.

In the next article it is proposed to refer to the more important patents and publications which have appeared relative to the continuous-current transformer ; and finally to examine into the probable outlay required for the supply of electricity to a given area under each of the four following systems :—

(1.) Battery transformers.
(2.) Alternate-current transformers.
(3.) Continuous current transformers.
(4.) Continuous-current transformers and batteries combined.

(To be continued.)

A PROPOSED NEW PUBLIC TELEPHONE SYSTEM FOR CITIES AND LARGE TOWNS.

BY WALKER MOSELEY.

(Continued from page 542.)

Next to the insulation of the wires the switch apparatus in telephone exchanges has caused most trouble and annoyance, and has latterly been the subject of numerous inventions, of which the most successful is that of the "multiple" switch-board. The object of these multiple switch-boards is that by their aid an operator may ascertain whether a certain number is disengaged, and can connect the same to any other without asking any question of any other operator. This is done by a system of sound signals, and still calls for some care and attention. The multiple switch that I have recently designed goes far beyond this in responding to all practical desiderata. It is based upon the principle of a lock, in so far that when an operator connects any given number to another, the apparatus, repeated on every other operator's board, is

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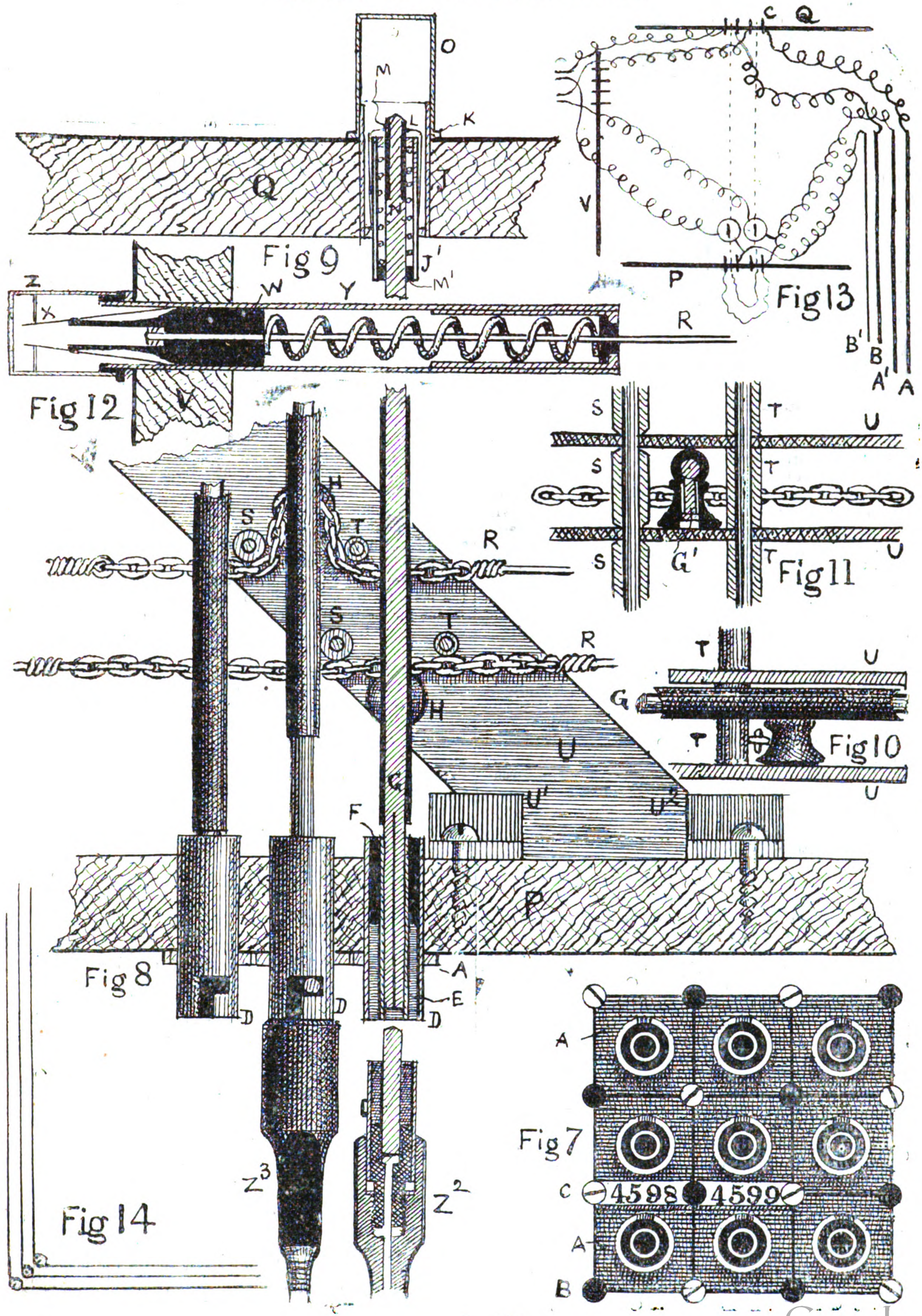
PROPOSED NEW TELEPHONE SYSTEM.



locked against access to those two numbers. In other words, if a certain number is *dis*engaged, any operator can connect to it without asking any question, or listening, or looking for any signal. But if it is engaged the switch plug, instead of entering freely, meets with rigid resistance, which not only means "engaged," but leaves no opening for interruption or eavesdropping.

The illustrations give nearly all the details of the apparatus by which the operations are effected. They are very nearly full size, with the exception of Figs. 13 and 14, and will be understood by the following descriptions :—Fig. 7 represents a small portion of the front of the operator's board, showing the connections for nine lines. A A, &c., are square metal plates, to which the tubes D, &c., are soldered. The plates are fixed to the board P (Fig. 8) by the screws C. The tubes D are insulated from the smaller tubes E by the ebonite insulator F, to which both are fixed. Inside the tube E is an iron rod, which extends through the back terminal board Q (Fig. 9). A tubular double-cased spring box, J J^1, keeps the back end of the rod in position. It is insulated from the spring box by the ebonite tube M and collar M^1. A square flange, K, is soldered to the outer tube, and at two corners—diagonally, as at Fig. 7—it is fixed with screws to the line terminal board Q.

The rod G is drawn in its normal position, in which position it is insulated from the line which is attached metallically to the spring box J J^1, of which O is a cover, but when the switch plug Z^2 is pushed home, as shown by Z^3, the portion of the iron rod which is covered by the ebonite tube M is carried beyond the tubular comb springs L, and the ends of the springs rest on a silver collar at N. Metallic contact is thus made with the iron rod G and the inner tube E, in the operator's board P. When this movement is performed the ebonite pulley H, which rotates on a strong round peg, G^1 (Fig. 11), fixed to—or really part of—the rod G (Figs. 8, 10, 11), engages the chain R, and carries it forward between the roller S and fixed pillar T. This movement of the chain has the following effect :—Being terminated at the right hand (beyond all the operator's boards) by fixture to the dead end board, and on the left by attachment to R (Fig. 12), the action described compresses the coiled spring in the tubular box Y (Fig. 12). As therefore each chain has only a certain allowance of slack it can be engaged by only one operator at once. Between each horizontal series of rods and chains, there are plates, U, fitted to the boards P and Q by grooved clamps, U^1, U^2. The spaces between each are accurately fixed by these grooves and by the pillars T, shown in section in Fig. 11. The pillars T and the rollers S are kept in position by steel wires running vertically through the whole vertical series. The spring boxes Y (Fig. 12) are fitted to the chain terminal board V, and are insulated from the covers Z. There are tubular comb springs, X, soldered to these spring boxes which, when the ebonite pieces W are in their normal position, as drawn, are kept in contact with the metal covers Z, by pressure against the inner edges of a hole through silver discs soldered to the cover Z, as shown in section Fig. 12. When any given number is engaged as described, the circuit previously completed by this contact spring X is interrupted, and the current, instead of travelling from line terminal board at K, Fig. 9, to Y, on chain terminal board V, Fig. 12, and through the connection to the cover Z, and thence to indicator (over operator's board) and to the return wire, the current travels from line terminal board, through the iron rod to E on operator's board, P, and through switch cord to any number that the other end of cord is connected to. These circuits are set out in Fig. 13, A and B being two lines, and A^1 B^1 being the return wires, P, Q, and V being the operators, line terminal, and chain terminal boards respectively.

The indicators are represented as being cut out of circuit when the lines are "put through," but it will be obvious that they may be left always in circuit by a slight change in the wire connection, without any alteration in the construction of the apparatus.

The springs in the spring boxes on line terminal board are auxiliary to the springs at chain terminal board, in order that by their direct pressure the rods G may be returned to their normal position with less actual force than would be required if the springs on board V were the only ones used. Hence the operator has less force to counteract than he would have in the latter case, and the operations do not cause fatigue or unpleasantness. The iron rods G are covered with ebonite to prevent any of the chains from making accidental contact. The front and back boards P and Q are kept accurately in position by strong stay rods in place of every 225th number, or, in other words, a stay rod for about every square foot. Indeed, each square foot may be a separate piece, all the pieces for one set forming one large panel in a strong frame. In case of accidents or wear and tear each hole through either the front or back board is notched to the depth of the diameter of the rod G, so as to allow the pulley H to pass through. In very large switch-boards, such as are required for more than 3,000 subscribers, it may be thought desirable to introduce guide rods and plates for some of the rods G on the left of the plates U (Fig. 8), in which case a partial repetition, with slight modification of the arrangement of plates U and upright wires S and T will suffice.

There are several other mechanical methods available for utilising the above described action of switch-locking, but any other would require too much space on account of having in large exchanges to turn one or two angles, as shown at Fig, 14, where the chain action requires only a small pulley for each chain. The numbering on the operator's board is provided for by slips of ivory long enough for two numbers, each pair of numbers being fixed between and under the heads of screws C, Fig. 7. The alternate pairs of corners, as at B, represent holes through which pairs of wires are passed to attach under the plates A. The illustration shows that the plugs Z^2 Z^3 fit into bayonet joints.

Although several matters of detail, more or less important, are omitted in the above description, it represents substantially the main features. It will be seen that there are no effective means for electrical connection to the front of operator's board, unless the switch plugs are pushed quite home.

As I have made no reference to any means by which the operator may "cut in" to ask what number is wanted, or whether any given pair of subscribers have done speaking, I may mention, without detail, that I propose to connect all the subscribers whose indicators are under the surpervision of a given operator to spring connections arranged in vertical series right and left of the operator, so that the pressure of any given button will open the corresponding circuit and put in circuit the operator's instruments. When the operator is asking for the number he will have a switch plug in hand ready to put in the number asked for, so that the reply, whether such number be engaged or not, may be almost instantaneous.

THE ELECTRIC LAUNCH "LADY COOPER."

We give illustrations this week of the electric launch "Lady Cooper," which, as we have already reported, made its first run on the day of the University boat race.

The launch is constructed of steel, and was built by Messrs. Redpath and Paris, of Limehouse, to the designs of the Electrical Power Storage Company. It is fitted with 66 cells of the latest T, or traction type, made by the E.P.S. Co., in which all the improvements of their "1888" type are embodied.

The cells contain 23 plates, and are capable of giving a discharge up to 40 amperes, and have a capacity at that rate of about 175 ampere-hours ; at a lower rate of discharge the capacity is considerably greater.

The motor was designed expressly for the boat, and gives efficiencies at the various powers of half speed to full speed, of from 78 to 85 per cent. It is somewhat heavier than is usually considered desirable, but the greater efficiency overcomes any objection of this kind. At full speed the motor makes 500 revolutions per minute, and is capable of efficiently working a screw of 24in. pitch

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The majority of the cells are placed under the floor, which is somewhat below the water line, the remainder being placed under the seats, which run along on either side of the boat. The starting gear, which is of a peculiar design (intended for tramcars as well as boats), enables the batteries to be coupled in series or in two parallels to the motor, giving an E.M.F. of either 66 volts and 18 amperes when in parallel, or 130 volts and 36 to 40 amperes when in series. The motor works with an almost entire absence of sparking under all conditions either of full speed or half-speed. The brushes are fixed in such manner that going either ahead or astern no attention beyond the movement of the switch lever is required.

Fig. 1.—The Electrical Power Storage Company's Electric Launch, "Lady Cooper."

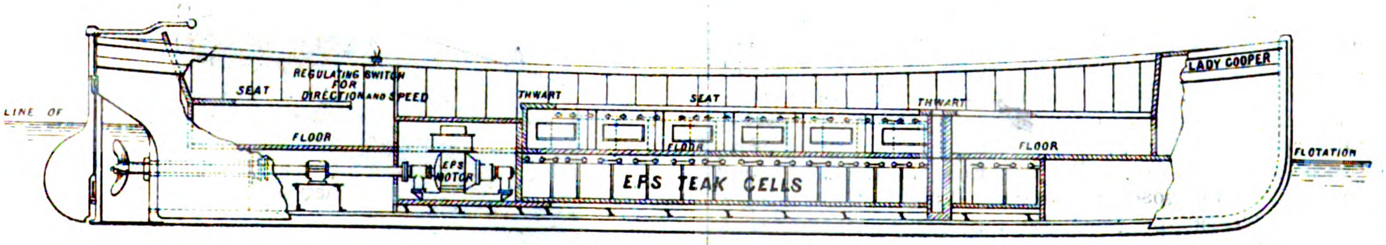

Fig. 2.—Longitudinal Section.

This boat is to be fitted with a cabin about 7ft. long, and will have an electric gong in place of the ordinary steam whistle as an alarm. It will be provided with a search light in

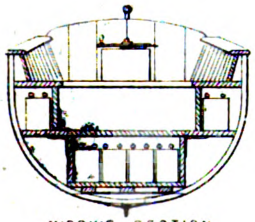

Fig. 3.

case it should be used for police purposes, and will also have a wheel in place of the present tiller, and with the experience gained it is hoped that still better results than the present speed of about 11½ miles on a tideway will be attained.

Fig. 1 is engraved from a photograph which was taken at Putney on the day of the boat race. Figs. 2 and 3 are longitudinal and midship sections.

TELEGRAPHIC COMMUNICATION BETWEEN CHINA AND EUROPE.

The United States Minister to China in a report to his Government describes a convention recently concluded at Chefoo between the representatives of the two telegraph companies having cables landed in China and the Chinese telegraph administration. The convention has created some alarm among the foreign mercantile communities in China, and has not yet been ratified by the Chinese Government, although the agents of the cable companies concerned spent the winter in Pekin for the purpose. Colonel Denby explains that the Great Northern Telegraph Company of Copenhagen and the Eastern Extension Company of London have divided the territory in China. The lines of the former run north through Japan to Vladivostock and Eastern Siberia, while the English company's lines run south through Singapore and India. Telegraphing to and from the interior is done over the Chinese lines, and, under arrangements hitherto existing, the Chinese telegraph administration received 50 cents per word for messages sent abroad from the interior. Under the arrangement proposed by the convention the Chinese would receive 70 cents. The companies, says the Minister, charge cable rates, although most of the service is by land. The following are the terms of the convention :—It sets forth that the Chinese telegraph administration intends to connect its system with the telegraph lines of adjacent countries, that the two companies also have this connection, and that it is desirable "to avoid competition." It is, therefore, agreed that all the traffic exchanged between any part of China, excepting the three ports of Shanghai, Foochow, and Amoy, on the one side, and Europe (Russia excepted) and countries beyond, on the other side, and *vice versâ*, transmitted by the land lines of the Chinese administration, whether by the land

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frontiers or the cables of the two companies, shall belong to the administration. For this traffic a terminal charge of 5 francs 50 centimes a word shall be fixed by the administration and shall belong to it. The like rate shall be fixed for all traffic exchanged by the land lines of the administration *viâ* the land frontier between Hong Kong, Amoy, Foochow, and Shanghai on the one side, and Europe (Russia excepted) and countries beyond, on the other side, which shall belong to the two companies, subject to a deduction of 10 per cent. of the receipts of the companies as hereinafter specified. The companies shall fix their rates on the traffic thus exchanged between Hong Kong, Amoy, Foochow and Shanghai and Europe, and the countries beyond, except Russia, by their cable routes *viâ* Siberia and India, at 5 francs 50 centimes per word, which shall belong to them, less the payment of the above-mentioned 10 per cent. The proceeds of all messages from and to the four ports mentioned, whether by the land lines or cables, shall belong to the companies, who shall pay 10 per cent. to the Chinese administration. When the land lines are interrupted for a period not exceeding 60 days the traffic may go over the cables without charge. The administration shall fix the rate for all traffic out of China at 5 francs 50 centimes per word. Government telegrams shall pay full rates, and no percentage shall be allowed thereon. The tariffs and payments fixed by the agreement shall not be changed unless by mutual consent. The parties to the agreement shall do all in their power to prevent the transmission of messages by any person or corporation at rates lower than those fixed, and neither party shall be interested in any other company, by sea or land, to the detriment of either of the others. The cables shall not be extended to any place in China or Corea without the consent of the Chinese administration, but existing land rights shall be preserved. The agreement is to take effect from the day that the administration shall connect their lines with the telegraph lines of any adjacent country in telegraphic communication with Europe, and shall be in force until May 19th, 1903. The American Minister says the substance of this agreement is that China will receive about $150,000 per annum more than she now gets, while the advantage to the cable companies is that for sixteen years they will have no serious competition. He does not regard the agreement as containing any principle of monopoly, because any one may lay cables to China from any part of the world. The two companies are rich, and consider that by cutting rates they can kill foreign competition. But in this it has to be observed that as the Chinese are a party to the agreement, they can prevent any enterprise of this nature by refusing to allow cables to be landed on their territory. The rates fixed in the agreement contain a slight concession to the general public, there being a reduction of 50 cents per word. But foreign merchants demand that the price be fixed at $1 per word. The companies, however, take the ground that no man telegraphs except when compelled to do so, and that their business would not be increased if the rate were reduced to $1.—*Times*, April 9th, 1888.

A PROPORTIONAL READING GALVANOMETER.*

BY DR A. D'ARSONVAL.

A genuine commercial galvanometer must be direct reading. Mirror instruments are very valuable for delicate research and measurement, but their place is, above all, in the laboratory. Direct-reading galvanometers have, as a rule, the defect of not giving deflections proportional to the current intensity. The maker is obliged to graduate them empirically, which complicates their construction very much, and at the same time increases the chances of error arising from graduation. For these and other reasons every new method allowing electrical instruments to be read direct constitutes a progress.

This question has occupied me for many years. In 1882 I found a solution, which is embodied in the apparatus shown in Fig. 1. This ammeter was made for me by M. Ducretet, and was exhibited at the Société de Physique in 1883 or 1884. Until now I had not thought of making it more public, because the use of mercury made it of little practical use; but recently I have overcome this defect as here described.

* *La Lumière Electrique*, 24th March, 1888.

The apparatus shown in Fig. 1 comes under the category of moveable-circuit galvanometers, which I brought into practical use in 1881 by adding to Deprez's "herring-bone" galvanometer the modification now known under the name of the Deprez-d'Arsonval galvanometer.

This ammeter can only be used for measuring strong currents. It has the advantage of giving proportional indications whatever may be the deflection, even if it exceeds 360 degrees.

The principle upon which it depends is that of the rotation of currents by magnets. A horse-shoe magnet, A, rests horizontally on three levelling screws; on one of the poles there is a vertical iron cylinder, C, hollowed out at the top and filled with mercury. The base of this iron cylinder is surrounded by a circular basin, D, which is of hard india-rubber, and has its circumference graduated. This basin is filled with mercury, which does not touch the iron cylinder, but which is in connection with it by means of a pillar, shown in the figure.

The other pole carries a vertical rod, along which slides a projecting bar, F, supporting the movable parts carrying the current. This arrangement is a simple metal bridge, B B′, consisting of two large copper wires, united at the top by a bar, and kept apart at the bottom by a ring carrying an index moving along the scale on the basin. The cross-bar at the top has a copper rod at the centre which dips into the mercury in the cylinder cup. This apparatus is suspended from the arm F by a metallic wire, E, which is at the same time suspension and torsion thread.

If one brings a current to the terminals of the apparatus shown in Fig. 1 it will be seen that the current enters at the basin D, ascends the movable conductor B B′, goes down the column C, and leaves by the magnet A.

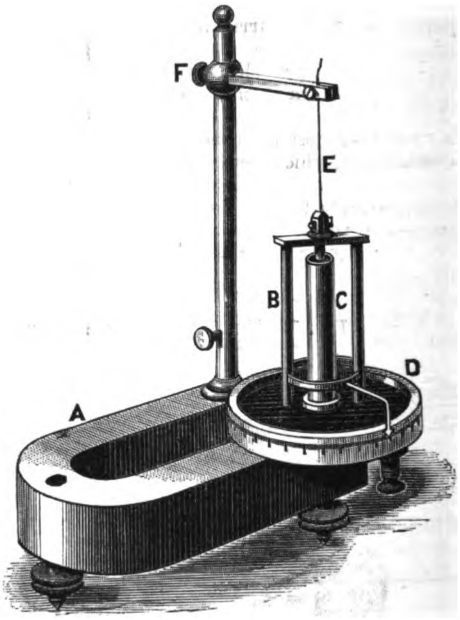

Fig. 1.

The well-known laws of electro-dynamics show that the movable conductor must turn continuously round the central magnetic pole C, the couples remaining the same whatever the position of the conductor B B with respect to the magnet C. This, in fact, is what would happen if the parts B B′ were pivoted; but, thanks to torsion thread E, this movement is limited, B B′ turns until the couple due to the torsion of the thread E balances the couple caused by the passage of the current.

The torsional couple is proportional to the angular deflection, on one hand; and since the moving couple is constant and independent of the angle of rotation, it will be seen that the deflections are strictly proportional to the current intensities, whatever the angle of deflection. The sensitiveness of the instrument depends, all things being equal, upon the diameter and length of the thread E, which may be very thin, since it only suspends B B′. The magnetic pole C may be replaced by an equivalent solenoid, but the instrument, as I have said, is by no means sensitive.

The great defect of this arrangement, which caused me to reject its use, was chiefly the impossibility of increasing the length of the circuit traversed by the current, and consequently the sensitiveness of the apparatus. The current ought to have the same direction in the two parts of the movable arrangement, which prevents us rolling it up into the form of a multiplier, as is done in the case of the so-called unipolar machines.

I succeeded in getting round this difficulty last year by the arrangement shown in Figs. 2 and 3.

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I take a tube of soft iron (Fig. 2), which I magnetise powerfully by attaching it to the south pole of a strongly magnetised sheaf, S. The conductor traversed by the current is rolled into the form of a frame, one of the sides of the frame coinciding with the axis of the magnetised soft-iron tube. This part of the conductor is thus screened from the action of the lines of force of the magnetic field. Moreover, I take this side of the frame as axis of rotation, by suspending it by means of two metallic threads placed one in prolongation of the other.

As in the Deprez-d'Arsonval instrument, these threads serve as conductor to the current, axis of rotation and torsional couple balancing the motive couple due to the passage of the current in the frame.

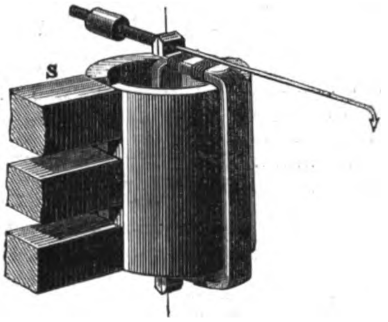

FIG. 2.

The upper part of the frame carries an index needle and counterweight, balancing the frame on its axis of rotation. By these means we are able to multiply the effect of the current to any desired degree, and yet obtain the conditions of the apparatus shown in Fig. 1.

The movable frame can describe nearly an entire circle; it is only stopped by the magnet S, which prevents it completing a revolution.

Fig. 2 is only a theoretical arrangement to make plain the principle of multiplication applied to the unipolar instrument. In reality, I greatly intensify the magnetic field by giving it an annular form. For this purpose the second pole of the magnet is bent concentrically round the iron tube, so that the movable part of the frame moves in a circular magnetic field of great density. Fig. 3 represents one of these arrangements. The magnet is of the Gower type.

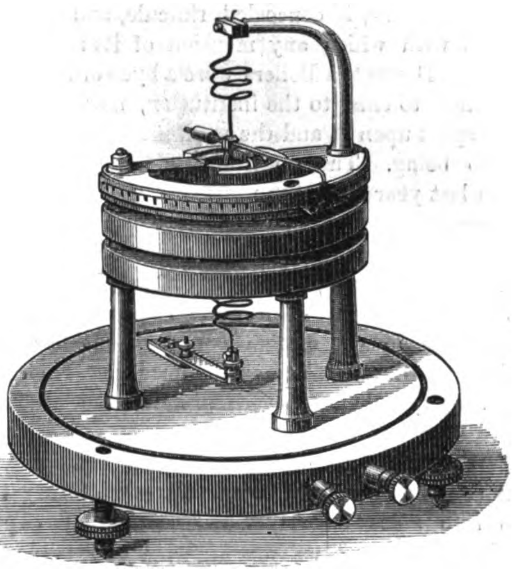

FIG. 3.

One of the poles carries the soft iron tube, the second pole terminates in another soft iron tube surrounding the first. The frame is suspended by two spiral springs or helices. We thus have an apparatus with deflections rigorously proportional up to 180°. If necessary it can be easily used up to 300°, but that is generally of no use.

It is not necessary for me to say that this instrument is absolutely dead-beat, and that it possesses all the valuable qualities which caused electricians to adopt the Deprez-d'Arsonval instrument.

MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-DAY) FRIDAY, April 13th.

PHYSICAL SOCIETY OF GLASGOW UNIVERSITY.

Paper on "Force and Energy." By Mr. W. WALLACE.

SOCIETY OF ARTS.

8 p.m. Indian Section. "The Experiences of Twenty Years in conducting Agricultural Inquiries in Southern India." By Mr. W. R. ROBERTSON, M.R.A.C., Principal, College of Agriculture, Madras. Chairman, Sir JAMES CAIRD, K.C.B.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper on "Joy's Valve-Gear applied to Locomotives." By Mr. H. H. CARRICK, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Lecture, "The Pygmy Races of Men." By Prof. FLOWER.

PARKE'S MUSEUM OF HYGIENE.

8 p.m. "Ventilation, Measurement of Cubic Space, &c." By Sir DOUGLAS GALTON, F.R.S.

SATURDAY, April 14th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Later Works of Richard Wagner" (1). By Mr. C. AMBRUSTER.

PHYSICAL SOCIETY (LONDON).

3 p.m. "On the Measurement of the E.M.F. of Dynamos." By Prof. W. E. AYRTON, F.R.S., and Prof. J. PERRY, F.R.S. "On the Variation of the Coefficients of Induction." By Mr. W. E. SUMPNER, B.Sc. "Some Experiments on Soap Bubbles." By Mr. C. V. BOYS. "On Electromotive Forces by Contact." By Mr. C. V. BURTON, B.Sc.

MONDAY, April 16th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture V. "Milk Supply and Butter and Cheese-Making" (2). By Mr. RICHARD BANNISTER.

TUESDAY, April 17th.

SOCIETY OF ARTS.

8 p.m. Foreign and Colonial Section. "A Hundred Years' Progress in New South Wales." By Mr. W. F. BUCHANAN, J.P. Mr. B. FRANCIS COBB, Chairman.

ROYAL VICTORIA HALL (Waterloo Bridge-road, S.E.).

8 p.m. Prof. GEO. HENSLOW on "Movements of Plants."

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed, "Compressed Oil-Gas and its Applications." By Mr. ARTHUR AYRES, M.Inst.C.E. Paper to be read, time permitting, "The Distribution of Hydraulic Power in London." By Mr. E. B. ELLINGTON, M.Inst.C.E.

ROYAL INSTITUTION.

3 p.m. Lecture, "John Ruskin" (2). By Dr. C. WALDSTEIN.

WEDNESDAY, April 18th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Telescopes for Stellar Photography." By Sir HOWARD GRUBB, F.R.S.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Meeting at the Institution of Civil Engineers. Papers to be read:—"Jordan's New Pattern Photographic Sunshine Recorder." By Mr. JAMES B. JORDAN. "On the Meteorology of South-Eastern China in 1886." By Mr. WILLIAM DOBERCK, Ph.D., F.R.Met.Soc. "Lightning in Snowstorms." By Prof. A. S. HERSCHEL, M.A., F.R.S. "Insolation." By Mr. RUPERT T. SMITH, M.Inst.C.E., F.R.Met.Soc.

THURSDAY, April 19th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Chemical Arts" (2). By Prof. DEWAR.

CHEMICAL SOCIETY.

8 p.m. Meeting.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

FRIDAY, April 20th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. "The Speed Trials of the latest addition to "The Admiral" Class of British War Vessels." By Mr. DAVID S. CAPPER, M.A. Stud.Inst.C.E.

ROYAL INSTITUTION

9 p.m. Lecture, "Antagonism." By the Right Hon. Sir WM. R. GROVE, M.A., LL.D., F.R.S., M.R.I.

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The Electrician.

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THE PROPRIETORS *of* "THE ELECTRICIAN" *beg to inform Electricians and Electric Light Engineers that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

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At the end of December in each year is issued THE ELECTRICIANS' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and has now attained considerable proportions. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, accompanied in many cases by Portraits.*

THE DIRECTORY FOR 1888 IS NOW READY.

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ANSWER TO CORRESPONDENT.

CHEMIST.—*You can obtain a practical acquaintance with electrical engineering at either of the City and Guilds of London Technical Colleges, or at the School of Electrical Engineering, Princes-street, W., or at some of the colleges in the North of England. In the United States there are several excellent schools, notably the Technological Institute at Boston, and the Cornell University at Ithaca, N.Y. You must not, however, imagine that a certificate from any one of these institutions will "ensure the student remunerative employment." The fact is that the profession in this country is already overcrowded with mediocrities, though there is always room at the front for men of undeniable merit. The States present a far better opening for the average electrical engineer at the present time. It is difficult or impossible to obtain instruction in an engineer's shop without paying a premium.*

SOUTH KENSINGTON.

Matters at South Kensington, it appears, are still a long way from being established on a satisfactory footing; and the undefined suspicions, ill-concealed ridicule, and outspoken disparagement with which any mention of its name used to be met when the Brompton Boilers were a byeword of mismanagement continue to cling to the institution, notwithstanding the vast sums spent upon it and the magnificent edifice they have called into being. These sentiments found some practical expression last year when the project of an Imperial Institute was set on foot, and would perhaps have proved fatal to it but for the energetic efforts of its Royal patron, and the loyal support of Colonial brethren, who are not infected with those prejudices which the mere mention of South Kensington invariably awakens in the mother country. It has been the usual fate of the last-named undertaking from the very first that every scheme which promises to become useful is in due time dwarfed and crippled by some fresh enterprise more pretentious than the one preceding it, nothing being thoroughly completed because the necessary funds are diverted into some entirely new channel of expenditure. South Kensington, as we all know, was intended for the advancement of Science and Art. Some people deny that it has succeeded in advancing either; but we may safely assert that if it has rendered some service to Science its services to Art have been far greater; and, indeed, the complaint that Art has been promoted at the expense of Science is perhaps not altogether without some justification. At all events, Art at South Kensington has a great deal to show for the money spent on it, while Science has not.

In the term Art we, of course, include architecture; and how splendid has been its expenditure on those sacred acres,

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the bricks and mortar are there to testify. They are not unworthy of the locality and the objects they are designed to further; but they have been erected without any general plan, or are appropriated for purposes which exclude in many cases the very objects which the Institution, as a whole, was intended to serve. A correspondent of *The Times* on Saturday last points out that the Royal College of Music about to be erected close to the Albert Hall will be ridiculous if it take any shape between a cloister and an eighteen-storied factory. Such is the consequence of having built without foresight a vast music hall to begin with, leaving the provision for teaching musical science to follow after. In the same paper is a report of the discussion in Parliament on the Civil Service Estimates relating to South Kensington, when a similar state of affairs was disclosed in connection with the Science Classes. In a speech at Newcastle a short time previously Lord RANDOLPH CHURCHILL is reported to have said that if the subjects of Science and Art were left to local effort their advancement would be secured without any aid from the Government. We do not agree with his Lordship in this, and it so happens that the local school he was referring to is an example of how local effort may be usefully supplemented by Government aid, without which, indeed, local effort probably would not have been evoked, and almost certainly would not have succeeded. But to the statement that in no other country of Europe is so little done as in England for Science and Art, his Lordship's rejoinder that we spend £500,000 a year on those objects is of considerable force, and he is not alone in thinking that we do not get what we are entitled to for so large an expenditure.

Sir H. ROSCOE is evidently, on this point, of Lord RANDOLPH'S opinion. The discussion arose on a vote to complete the sum of £9,000 for science and art buildings. Now, as we have already said, the most conspicuous—perhaps the only discoverable—examples of lavish expenditure on the non-official features of South Kensington are the buildings; yet, although fresh demands are continually made for their enlargement or beautification, the member for South Manchester roundly declared that "the accommodation at the only Government school in this country for teaching science teachers would be a disgrace to any third-rate German town." We do not attach much importance to comparisons of this sort; but going on to particulars nearer home the facts do seem to warrant the term disgraceful. He had, said Sir H. ROSCOE, that day visited the Science School at South Kensington, under the able control of Prof. RÜCKER. It occupied a temporary building, rented from the Commissioners, and was used as a laboratory. This building, utterly insufficient already, was about to be taken away from the Science School because the ground was required for the Imperial Institute! Here we have the old story over again, only this time in a reverse order, science being elbowed into a corner, and then thrust out of the back door to make room for a more popular or more influential tenant. One would have supposed that not only space but building accommodation was still plentiful enough at South Kensington; but according to Sir H. ROSCOE the students who now work in the laboratory would be thrown out of employment, and the school would have to reject a large number of applicants who wished to study there. The school, be it remembered, is not a gratuitous one, subsisting on the generosity of the State; the fees amount to £3,500 a year from the students alone; and if they are scattered, as we hope and trust, thanks to Sir H. ROSCOE'S interposition, they may not be, this large sum will go with them elsewhere. It has been a matter of some surprise that the City and Guilds Central Institute has lately taken in hand the training of science teachers, a function which the nation has a right to expect should be discharged by the South Kensington educational machinery. But after this explanation we can only congratulate ourselves that there is the City and Guilds Institute to fall back upon where the State institute has failed.

Mr. PLUNKET, representing the Office of Works in this matter, confessed its inability to deal with the existing congestion satisfactorily so long as the South Kensington authorities and the Treasury differ in their views as to what ought to be done. It will be news to most people that, according to Mr. PLUNKET, the Science and Art Department has "very clear and wide views" as to provision being made "not only for present needs, but for the future development of this great institution." On the other hand, the Treasury has equally clear but narrower views on this subject; and in the light of past experience nobody can seriously wonder at it. The clearness of the views at South Kensington has not been very apparent hitherto, whatever their breadth may have been. At present both characteristics are said to be concentrated on preserving "four large handsome residences at the eastern side of Exhibition-road" for the occupation of certain officers of the Department, the Treasury being equally fixed in its determination to utilise those handsome residences for temporarily relieving the congestion in the main buildings. We offer no opinion on this grave question of official residences. All other things being accommodated, it is obviously desirable that officers of educational establishments, including, of course, the professional staff, should live on the premises. But we are not told who the officers are; and it strikes us as odd that no better reason for their presence in "four large handsome residences" adjoining is put forward than that, in the event of the museum catching fire, their occupants would be able to indicate where the most precious of its treasures are stored. This, from an ex-Minister like Mr. MUNDELLA, and others who took the same line, rather discounts their professed anxiety to find adequate accommodation for science teaching, coupled with their protestations against extravagant expenditure. Lord RANDOLPH CHURCHILL has obtained promise of a return showing all the sums that have been spent on the South Kensington buildings. For our part, we should like to know the sum that has been spent on Science teaching. It would not amount to very much, we fear, if the receipts were set against the expenditure. But whatever it has cost, the duty of promoting technical education is one that the nation has made up its mind to perform, and we trust no effort will be spared to prevent the threatened scandal to which Sir H. ROSCOE drew the attention of Parliament last Friday evening.

ROYAL METEOROLOGICAL SOCIETY'S EXHIBITION.

BY WILLIAM MARRIOTT, F.R.MET.SOC.

(Continued from page 595.)

The exhibition contained numerous objects which had been damaged by lightning. The Royal College of Surgeons exhibited the clothes of a man which were torn off his body by lightning on June 8th, 1878, while standing under a tree near Ashford, Kent. These comprised a cotton jacket, flannel undervest, trousers, stockings, garters, boots, and watch. The man when struck was thrown some distance from the tree, while most of his clothes were torn completely off his body and hurled a considerable distance beyond. The man was not killed, but was rendered unconscious; he is still alive, but has a great horror of thunderstorms!

Two photographs were exhibited which further illustrated the effects of lightning on human beings. The first was of the shoes of some children who were struck in Atcham Church, Shrewsbury, in July, 1879. These were burst out in a similar

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manner to those of the man already referred to. The second photograph was of the arm of a boy struck by lightning at Dunse, Berwickshire, on June 9th, 1883, showing the arborescent markings.

Mr. W. Leonarde exhibited specimens of telegraph and signalling apparatus used on the South-Eastern Railway which had been damaged in thunderstorms, and the Postal Telegraph Department showed portions of a telegraph line wire which was fused by lightning at Stornoway on May 1st, 1884.

Prof. D. Colladon sent a case of interesting specimens, showing the effects of lightning on trees, &c.; while other exhibitors showed portions of a rafter, pieces of wood and bark from various trees, &c., all of which had been struck by lightning. The destructive effects of lightning were also illustrated by numerous photographs.

Mr. Symons, at the meeting of the Society, read a paper "On the Non-Existence of Thunderbolts; elucidated by accounts of searches after them" (*see* page 545). The specimens of these so-called thunderbolts were included in the exhibition, and were of a very amusing nature. One was a cannon ball, which was found at the bottom of a hole in a manure heap, after a flash of lightning had struck near it. A second alleged thunderbolt, which was reported to have fallen in Westbourne Park, Notting Hill, on June 30th, 1866, was really a piece of coal; while a third, which was stated to have fallen at Kilburn on July 5th, 1877, was merely a clinker from a fire engine. The largest so-called thunderbolt exhibited was that which is reported to have fallen at Casterton, in Westmoreland, sometime between 1830 and 1840. This is said to have fallen under a large tree, killing a sheep, and penetrating the ground to a depth of about six feet, and when afterwards dug up was quite hot. In appearance it much resembled a volcanic bomb; it is, however, really a nodule of sandstone, but was doubtless found in the hole made by the lightning flash.

Closely allied to thunderbolts are fulgurites, which are formed by the lightning penetrating a bed of sand containing much silex, and fusing the sand into a kind of glass. Two drawings of fulgurites were exhibited, one being about 9ft. long. The actual fulgurite is in the British Museum, for which it was purchased in 1851.

A number of meteorites were also exhibited, one of which shows the Widmanstätten figures. Mr. W. Sowerby showed a piece of the meteoric iron found near the Great Fish River, Cape of Good Hope. This contains about 10 per cent. of nickel. Of a portion of this meteorite Mr. James Sowerby had a sword forged, and presented it to the Emperor of Russia in 1814.

A prominent feature of the exhibition was the valuable and interesting collection of photographs of flashes of lightning, which had been received in response to a circular issued by the Council of the Royal Meteorological Society in June last asking for such photographs. More than 50 photographs were exhibited, the specimens coming from all parts of the world. It is the practice of artists to represent lightning in their pictures as a series of zig-zags. True lightning, however, as shown by the photographs, does not take such a path, but passes along in an undulating and sometimes very erratic course. Side by side with these photographs were exhibited three diagrams of lightning made by Mr. James Nasmyth, F.R.S., in 1856, showing—1. Nature's lightning; 2. Painter's lightning; and 3. Forked lightning. The form of lightning as depicted by Mr. Nasmyth very closely resembles that pourtrayed in the photographs, and shows what a careful and accurate observer Mr. Nasmyth must have been. From an examination of the photographs it seems that the lightning flash does not always appear as a mere line of light. Several of the flashes have a ribbon-like appearance, and seem to be of a perceptible breadth, while in one of the photographs there is a *dark* flash. A large number of photographs of flashes of lightning were taken in London during the great thunderstorm on August 17 last. Mr. E. S. Shepherd, of Westbourne Grove, succeeded in obtaining eight photographs during this storm, one of which is reproduced in Fig. 7. Some of the photographs taken in the United States were of great beauty, especially those obtained by Mr. L. S. Clarke on the top of the Alleghany Mountains on August 2, 1887; one of these is reproduced in Fig. 8. The Royal Meteorological Society had enlargements made of five of the American photographs, and these showed up the flashes to great advantage.

Several new instruments were exhibited, including Dines's maximum wind pressure instrument, Rechnagel's electric anemometer, Tripe's arrangement of the rain-band spectroscope, Colladon's instrument for illustrating the formation of waterspouts, the Schanschieff electric lamp, Jordan's new pattern photographic sunshine recorder, &c.

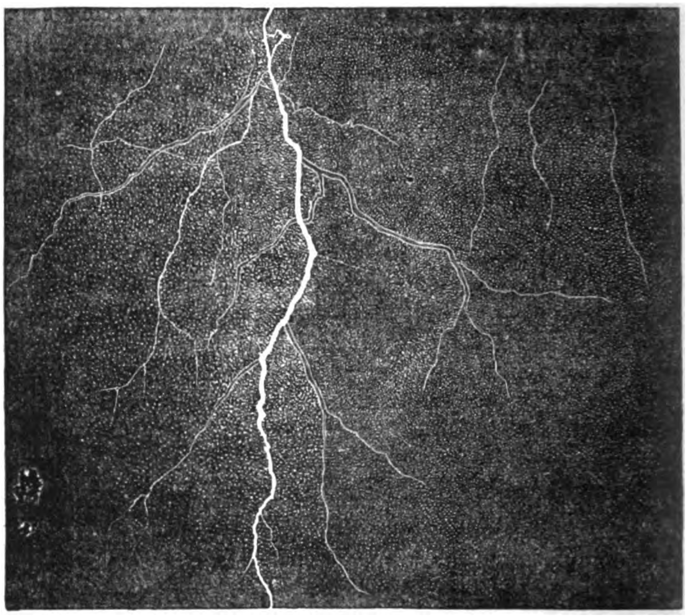

FIG 7.

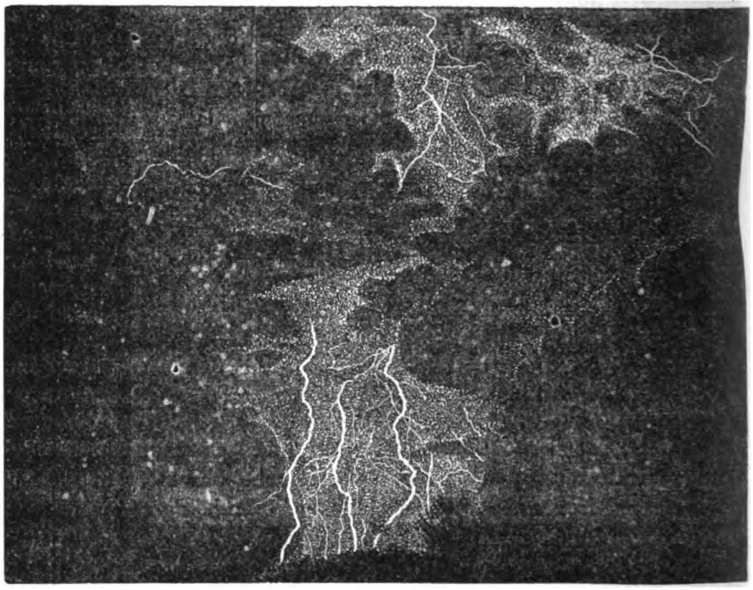

FIG 8.

Prof. Colladon's instrument for illustrating the formation of waterspouts is a very pretty arrangement, and attracted a considerable amount of notice. It consists of a large glass vessel, almost filled with water, and into which has been thrown some sawdust, which soon sinks to the bottom. On turning a handle a fan revolves in the water, and imparts to it a circular motion. Very soon the dust at the bottom begins to revolve, and is then drawn up in a column, and looks exactly like a waterspout.

The Schanschieff portable electric lamp is a very ingenious arrangement. The lamps are made in three patterns, viz., a four cell reversible and a three and four-cell round,

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with dipping elements. The weight of the small pattern is about 6lb. The battery is a single fluid primary one, entirely self-contained. It is a very simple combination of carbon-zinc elements, charged by a special solution of a salt of mercury. When in action the mercury is deposited in the cells, and is thus not lost. The carbon plates do not require renewing, and will last an indefinite time, while the zincs only require to be renewed after about 60 hours' work. In the reversible pattern, when the light is required, it is only necessary to reverse the position of the lamp, by which motion the battery elements become immersed in the solution, and the lamp is brought to incandescence. Again reversing its position, the lamp is at once put out of action.

A large number of photographs of meteorological instruments, of clouds, &c., were also exhibited, as well as several photographic records of atmospheric electricity by Thomson's electrometer at the Greenwich and Kew Observatories. These showed the disturbance of the electrical condition of the atmosphere during the snowstorm on Dec. 26th-27th, 1886, and during the thunderstorms on May 22nd, 1886, and August 17th, 1887. Prof. H. Dufour also sent some photographic records from his electrometer at Lausanne, Switzerland. These showed the kind of electricity that was recorded during certain types of weather, *e.g.*, fine, cloudy, rain, snow, hail, thunderstorm, &c.

A striking photograph was that showing Krakatoa in eruption in May, 1883. This was reproduced from a photograph taken on board a steamer.

REVIEWS.

Proceedings of the Royal Society of Edinburgh, Session 1886-87. No. 124.

The contents of the present number of the *Proceedings* of the Royal Society of Edinburgh comprise the papers presented during the period from May 2nd to July 18th, 1887; from which it will be seen that the publications of this Society are not characterised by amazing promptitude. The electrical papers contained in the present number are not numerous, but they nevertheless comprise researches which should fill a permanent niche in the records of electrical science. We refer more especially to the two papers by Mr. W. Peddie, B.Sc., "On the Increase of Electrolytic Polarisation with Time," and "On Transition Resistance at the Surface of Platinum Electrodes, and the Action of Condensed Gaseous Films." The occurrence of a surface resistance between certain electrodes and the solution was first enunciated by Dr. Gore in a paper read before the Birmingham Philosophical Society. But inasmuch as the phenomena is with difficulty discriminated from that of counter E.M.F., it has not hitherto met with universal recognition. Attempts have been made to settle the question by ascertaining whether the heat effect (C^2R) is proportionately greater at the surface of the plate, but the experiments have not proved satisfactory.

Mr. Peddie's research, however, offers evidence of a very conclusive character, and not only proves the reality of transition resistance, but shows also that it is due to the occlusion of a gaseous film upon the surface of the electrode. The experiments were made by taking a series of observations of the current strength of one Daniell cell through a pair of platinum electrodes immersed in dilute sulphuric acid. The E.M.F. was, of course, insufficient to effect decomposition. In the first case the electrodes were allowed to remain in the acid for several hours before the experiments were made. Since only one Daniell cell was used the liquid was not decomposed, and the current strength after two or three seconds was only of the order of thousandths or ten-thousandths of an ampere, and continued to fall. A curve was then plotted of the values of the current at certain intervals. The plates were afterwards taken out, heated to redness, replaced, and a second series of observations was made. It was then found that the current was now very much larger than before, but that by the insertion of resistance in the circuit the original curve could be almost exactly reproduced. The specific resistance of the gas film might perhaps be obtained in this way if we could estimate the thickness of the film with sufficient accuracy. Mr. Peddie concludes only that "the order of the specific resistance is the same as that of ordinary dielectrics."

Mr. Albert Campbell, B.A., has an important paper "On the Direct Measurement of the Peltier Effect." Hitherto it has been a pure assumption that the Peltier effect vanishes at the neutral point. The chief object of Mr. Campbell's experiments was to obtain direct evidence as to the truth of that assumption. The experimental investigation of this subject is by no means an easy task, owing chiefly to the difficulty of measuring and maintaining constant the high temperatures required.

The results, however, were of a very fairly concordant character, and serve to justify the theory as already understood. The following extract may serve to convey a useful hint for other experiments in which time readings are required:—

"In order to investigate the rate at which the growing Peltier effect temperature-difference showed itself by the thermopile deflection, the following simple chronographic method was adopted. In this a number of observers were made use of. Observer A held a watch to his ear, and counted half-seconds aloud in exact time with its beats, also making and breaking the battery circuit at exactly the proper times. Observer B, watching the galvanometer scale, said sharply the syllables, 'Tic, tac, to, tee, tic, tac, to, tee,' and so on, as the light-spot passed over certain prearranged divisions of the scale. Eight other observers noted down the numbers after which they heard the tic, tac, to, or tee, one of those words being allotted to each pair of observers. This method proved wonderfully accurate. The pairs of observers very seldom disagreed by half a second, although the numbers had to be noted very rapidly."

Fortschritte der Electrotechnik. By Drs. Karl Strecker, Dobrowolski, Kiliani, and Pirani. (Berlin: Julius Springer, 3 Monbijouplatz.)

The present number of this quarterly catalogues the current electrical literature of the third quarter of last year. It will be found well up to the mark of the first two parts, which we noticed in December last. It contains some 1,200 headings, each with several references to various journals.

THE SIZE OF INCANDESCENT LAMP FILAMENTS.

Commenting on the fact that the efficiency of incandescent lamps with stout filaments is greater than those with fine, M. Hospitalier points out in *L'Electricien* that several different causes combine to render this the case. If, for example, we take the case of two lamps, each absorbing 64 watts, but let one have a fine filament having a resistance of 64 ohms, whilst that belonging to the other is one-fourth the length and four times the diameter, thus having a resistance of one ohm only, then the volume of the second will have consequently a greater calorific capacity, so that the effects of any accidental variations in the strength of the current will be greatly diminished. Moreover, the section of the second filament will be 16 times that of the first, whilst the current passing through will be only eight times as great; hence the current density will be only one-half of what it is in the fine filament. Adding to this the fact that it is easier to secure uniformity in the manufacture of stout filaments than of fine, there appears ample ground theoretically for the longer life of stout filaments, which practical experience shows.

Writing on the same subject in *La Lumière Electrique*, M. Henrique gives the following formulæ for filaments of cylindrical section, and for lamps of the same voltage:—

"If a lamp of n candle-power has a filament of length l_n, and diameter D_n, then the length and diameter of a filament of the same make to give m candles at the same efficiency, must satisfy the equations

$$\frac{l_m}{D^2_m} = \frac{n}{m} \frac{l_n}{D_n^2} \qquad (1)$$

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and $$l_m D_m = \frac{m}{n} l_n D_n \quad . \quad . \quad . \quad . \quad . \quad (2)$$

"Equation (1) follows from the consideration that for the same efficiency the resistance of the filaments must be inversely as their candle-power. Equation (2) follows from the fact that for the same efficiency the surface temperatures must be the same, and therefore the radiating surface (neglecting the influence of the attachments) must vary directly as the candle-power. Resolving these simultaneous equations we get

$$\frac{Dm}{Dn} = \sqrt[3]{\frac{m^2}{n^2}}, \text{ and } \frac{l\,m}{l\,n} = \sqrt[3]{\frac{m}{n}}.$$

"According to this formula, in order that two lamps of the same type may have the same efficiency while one has twice the candle-power of the other, the lengths of the filaments must be as $1 : \sqrt[3]{2}$, or as 1 : 1·26, and the diameter as $1 : \sqrt[3]{4}$, or as 1 : 1·59 (nearly)."

THE OUTPUT OF DYNAMOS PER UNIT WEIGHT OF COPPER.

Accurate comparisons between the performances of different dynamos are well known to be very difficult to put in such a form as to be any real index of the relative values of such machines. If, for instance, we tabulate the relative output per unit weight of copper, this tells us very little in the absence of information as to the peripheral speed of the armature current density allowed (or, still better the temperature of the coils after running for some time at full load). However, we give the following table, which has been compiled by M. W. Peukert *(Zeitschrift für Electrotechnik)*, for what it may be worth :—

	Machine.	Revolutions per minute.	Diff'r'nce of potential in volts.	Output in watts.	Total weight of copper in kgs.	Gms. of copper per watt.
1	Crompton	400	600	72·000	637·1	8·85
2	Crompton	700	110	54·000	473·7	8·77
3	Ganz and Co. (VP_5)	670	105	50·400	240 0	4·76
4	Goolden-Trotter	765	56	16·000	104·6	6·54
5	Goolden-Trotter	1,070	77	22·400	104·7	4·67
6	Brush	400	80	300·000	3000·0	10·0
7	Ganz and Co. (machines with 6 poles)	1,000	1,500	52·500	82·0	1·56
8	Crompton (type No. 30)	440	110	25·500	395·0	15·5
9	Mather and Platt	1,000	100	22 000	144·0	6·4
10	Lahmeyer, G. (III.)	1,250	65	3·900	50·3	12·89
11	H. Pöge	840	65	6·500	58·3	8·96
12	Bollmann	750	100	100·000	556·0	5·5
13	J. Einstein and Co.	1,100	100	4·500	35 0	7·7
14	Edison-Hopkinson	800	100	33·000	118·0	3·57
15	C. E. L. Brown	1,000	65	10·400	45·0	4·32
16	C. E. L. Brown	1,000	55	6·600	21·6	3·3
17	Brush	1,000	100	380 000	2833·0	7 45
18	Elwell-Parker	1,000	110	50·600	454 0	9·1
19	E. Fein (machine with interior poles)	520	110	15·000	88·4	5·88

The extraordinary differences between the performances of the various machines is in some cases difficult to account for, even when reasonable allowance is made for the known and unknown conditions. For instance, it would be interesting to know how it happens that in the two machines, Nos. 1 and 8, by the same makers, so great a difference exists. Both are slow-speed machines, but one runs 40 revolutions faster than the other, and yet the slower machine has a greater output per unit weight of copper in the ratio of 15·5 to 8·85. The performance of the high-tension machine of Messrs. Ganz and Co., which yields a watt for every 1·56 gramme of copper, is, if correct, something which that firm may justly be proud of.

Dr. Kohlrauch.—The *Centralblatt für Electrotechnische* states that Dr. F. Kohlrauch has accepted the Chair of Physics at the University of Strassburg and Ostern. The appointment has caused the greatest satisfaction among the leading scientists of Bavaria.

CENTRAL STATION LIGHTING.—TRANSFORMERS v. ACCUMULATORS.*

BY R. E. CROMPTON.

The present Paper is the outcome of the discussion which took place on Messrs. Kapp's and Mackenzie's Papers on tranformers, recently read before this Society. I was asked to give facts and figures in support of the statement I then made, that I believed the distribution of electricity by transformers offered no special advantages over other methods, particularly over distribution by means of accumulators used as transformers.

However, after compiling the statement of facts and figures necessary for my purpose, I found that I had undertaken a task of a much heavier nature than I originally intended ; and I must apologise for the present Paper having a much wider scope than its title would warrant.

In fact, I find it necessary to commence by discussing some of the conditions of the supply of electricity from electric stations which are common to all systems of distribution, and about which little or nothing has hitherto been written or said. In England central station lighting has been such an affair of yesterday that it is hardly to be wondered that what little knowledge exists on the subject should be confined to the few who have lighting stations under their immediate charge ; and when we look to the Continent, or to America, to supplement this meagre stock of knowledge, we find the conditions of demand for light differ from those of a large English town, such as London, so that they do not much help us in our investigation. However, during the past few years I have done my best to make myself acquainted with the main facts which appear likely to govern the future commercial success of such undertakings.

I must at once divide the schemes for electric supply into two classes :—1st, those confessedly carried out in a temporary manner, and for the purpose of popularising the electric light, and inspiring the confidence of the public in supply companies as a form of investment ; and 2ndly, those intended to be of as permanent a nature as the gas supply, with which they come into competition. I think to the first class we must relegate such systems of supply as those at Brighton, Eastbourne, the present supply from the Grosvenor Gallery, in fact all those which distribute by means of overhead wires, picking their customers here and there, and which, although they have served a very useful turn in familiarising the public with the use of the electric light, cannot be considered as in any sense fitted to develop themselves into a complete system of supply when the time arrives that more than half the houses may be expected to take the light.

In order to get an adequate idea of the nature of the demand, or what I call the load diagram of a system of supply, we cannot do better than refer to the diagrams of a similar nature taken by the gas companies. Having recently had the advantage of carrying out electric supply stations for several gas companies, I have had access to such load diagrams for gas lighting, and from these and from the experience already obtained of electric supply in London, I have constructed a load diagram which I believe will be found a fairly representative one for an ordinary London residential district, consisting partly of private houses, partly of shops, with the usual sprinkling of hotels and public buildings. No doubt a district containing a very large number of theatres would have a somewhat different diagram, but not differing so much as to materially affect the arguments that I am about to found on these load diagrams. Through the kindness of Dr. Fleming, I am able to lay before you several load diagrams obtained from lighting stations in America, which you see coincide very fairly with the one I have prepared for London. We learn from these load diagrams—1st, that the average daily outputs in units throughout the year is about three and a-half times the maximum load in kilowatts ; in other words, that a station having a plant equal to the supply of 600 kilowatts—that is to say, 10,000 lamps, of 16 candle-power, each simultaneously alight—could only calculate on selling an average quantity of 2,100 units per day. This fact, which has such an important bearing on the possible profits to be obtained from a station of a given size, appears to have been completely ignored by the writer of an article on central stations in *Industries* dated the 2nd December, 1887, who estimates that a plant of this size would be able to supply daily 3,600 Board of Trade units, which is 73 per cent. in excess of the figure I have given above. The next point we have to note, common to all systems of distribution, is the extent of underground mains necessary to distribute a given supply of electricity, and the probable cost of such mains when laid underneath the footways of our streets. Starting once more on the above-quoted 10,000-light plant basis, I find, from careful note of the transformed to currents of low E.M.F., suitable to the glow and arc lamps used by the consumers, and which I hereafter call the

* Paper read before the Society of Telegraph-Engineers and Electricians yesterday, Thursday, April 12th, 1888.

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TABLE No. 1.

COST OF LAYING 100 YARDS OF DOUBLE CONDUCTOR UNDERNEATH THE FOOTWAY OF A LONDON STREET.

—	Single. No. 16.	7/16	19/15	19/12	19/10	37/10	Two Sets. 37/10	Four Sets. 37/10	Six Sets. 37/10
Area, square inch	·0032	·0225	·0773	·1613	0·25	0·5	1·0	2·0	3·0
Area, square millimetre	2·08	14·6	50	104	161·25	322	645	1,290	1,935
Weight per 100 yards run ... lb.	7½	53½	183¼	392	576	1,153	2,306	4,612	6,918
Cost of copper at 7¾d.	£0 4 10	1 14 6	5 18 0	12 13 0	18 15 0	37 5 0	74 10 0	149 0 0	224 0 0
Cost of insulation	1 3 2	4 8 6	11 2 0	24 17 0	35 17 0	70 15 0	141 10 0	283 0 0	424 0 0
Total cost of cables	£1 8 0	6 3 0	17 0 0	37 10 0	54 12 0	108 0 0	216 0 0	432 0 0	648 0 0
Casing, bitumen, and cement	5 3 0	5 5 0	8 0 0	12 10 0	12 10 0	16 0 0	22 0 0	40 0 0	55 0 0
Labour laying	3 0 0	4 0 0	5 0 0	5 0 0	6 0 0	10 0 0	18 0 0	35 0 0	50 0 0
Trenching and repairing	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	30 0 0	35 0 0
Surface boxes and connection	5 0 0	7 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0
Engineer and superintendent	3 0 0	4 0 0	5 0 0	5 0 0	6 0 0	10 0 0	10 0 0	20 0 0	25 0 0
Total	£42 11 0	51 8 0	70 0 0	95 0 0	114 2 0	179 0 0	301 0 0	567 0 0	823 0 0
Add extra, if copper at 9½d.	0 1 1	0 8 0	1 7 0	2 17 0	3 5 0	8 10 0	17 0 0	34 0 0	51 0 0
	£42 12 1	51 16 0	71 7 0	97 17 0	117 7 0	187 10 0	318 0 0	601 0 0	874 0 0
Cost of copper per lb., laid complete	5 13 6	0 19 4	0 7 9	0 5 0	0 4 1	0 3 3½	0 2 8¾	0 2 7¼	0 2 6¼
Current in amperes	1·2	8·1	28	58	90	180	360	720	1,080
Cost per ampere	35 10 0	6 8 0	2 10 6	1 13 9	1 6 0	1 1 0	0 17 6	0 16 8	0 16 1

TABLE No. 2.

COST OF LAYING 100 YARDS OF DOUBLE CONDUCTOR OF BARE COPPER CARRIED ON INSULATORS IN A CULVERT.

Area in square inches	0·25	0·5	1·0	2·0	2·55	3·00
Area in square millimetres	161·25	322·5	645	1290	1645	1935
Weight of copper in lbs. per 100 yards	576	1153	2306	4612	6125	6918
Cost of copper at 7¾d. per lb.	£18 15 0	£37 5 0	£74 10 0	£149 0 0	£190 0 0	£224 0 0
Laying	9 0 0	9 12 0	9 12 0	9 15 0	9 15 0	10 0 0
Insulators	0 4 6	0 4 6	0 4 6	0 4 6	0 4 6	0 4 6
Six surface boxes and connections	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0
Culvert, 18 inches × 12 inches, for 2 lines conductor, in brickwork and cement, replacing pavement	53 8 0	53 8 0	53 8 0	53 8 0	53 8 0	53 8 0
Engineers and superintendence	6 0 0	10 0 0	10 0 0	10 0 0	10 0 0	15 0 0
Total	£97 7 6	£120 9 6	£157 14 0	£232 7 6	£263 7 6	£312 12 6
Extra for copper at 9½d. per lb.	3 5 0	8 10 0	17 0 0	34 0 0	43 10 0	51 0 0
Total	£100 12 6	£128 19 6	£174 14 6	£266 7 6	£306 7 6	£363 12 6
Cost of copper per lb. laid complete	42d.	27d.	18·2d.	13·8d.	12d.	12·6d.
Current in amperes	90	180	360	720	910	1,080
Cost per ampere	1 2 3	0 14 5	0 9 8	0 7 5	0 6 9	0 6 8½

amount of electricity used by various classes of houses, that in order to sell an average of 2,100 units per day our distributing mains must reach not less than 1,000 houses. We may take the average width of the London house at 10 yards; to this we must add 50 per cent., on the supposition that only two houses out of three will take the light for some time to come; and on to this we must again add 30 per cent. for such proportions of the roads, such as crossings, dead walls, &c., traversed by the mains which do not front houses taking the light. We thus find that every house requires 20 yards of distributing main; or to distribute the daily average supply of 2,100 units, 20,000 yards of main. In addition to these distributing mains we must contemplate the probability of the generating station being placed at a distance of 2,000 yards from the centre of the district supplied, so that in all we have to provide 22,000 yards of mains of the two classes of mains. For convenience of nomenclature I call those mains which form the primary wire to the transformers, or carry the charging current to the accumulators, "charging mains;" and those from the transformers to the houses, or from the accumulators to the houses, "distributing mains." Next, as to the cost of these mains. I have prepared two tables, which show how wide of the mark is the popular idea that the cost of the mains is greatly influenced by the cost of the copper conductors themselves. I have stated at this Institution that much nonsense has been talked on the subject of the cost of copper; by this I did not intend to be disrespectful to any particular speaker, but to point out in strong language that the habit of basing estimates of distribution on the cost of copper (with but a small percentage added for insulation and laying) was one to be avoided, as it has led to erroneous conclusions, on which have been based arguments far too favourable to systems using currents of high E.M.F.

No doubt this habit of considering the cost of copper as such an important element in the calculation has arisen from the fact that, although this question of electrical distribution has been for years under discussion, and has had volumes written about it, yet our experience in laying and repairing such conductors has been until quite recently almost *nil*. The tables now before you are based on the little experience that I have gained during the last three years, and I trust they may be of some service to the Members of the Institution. Many of the figures are the actual prices paid out on executed contracts, and the other ones are calculated from them; so that it is quite certain that the figures quoted in the table are not far wide of the mark. You will notice that, apart from the price of the copper itself, the additions we have had to make for the insulation troughing, cost of laying, providing and fixing surface boxes, digging and guarding the trenches, taking up and replacing the flagging and wood pavements, are almost a constant quantity depending only on the length of the roadway that is disturbed, and, consequently, when considered in relation to the cost of copper itself, are at a maximum when the section of the copper is small and decrease rapidly as the section augments.

Table No. 1 is for laying copper in the form of insulated cables in the old and well-tried way. Table No. 2 is for a form of main which I have successfully adopted during the past year, and which consists of a bare copper conductor, supported and insulated in concrete subways or culverts by porcelain insulators. I am not at present submitting the latter system for your criticism. In some respects it is not yet perfect; but I mention it as I am employing it to a considerable extent myself, and believe that it will prove a very valuable form of conductor for whatever system of distribution is used. The completed main consists of such very durable materials, and the facilities for repairs and renewals, or for increase in the section of the conductor, are so great, that the annual charge for the upkeep and depreciation of these mains is not likely to exceed 25 per cent. of that of the older form of cables insulated with the continuous covering, whatever material may be employed for that covering.

With these considerations of the load diagrams, the extent of distributing system, and the cost of the mains before us, we can now proceed to compare the merits of distributing the electricity by two systems—the first being by alternating currents of high E.M.F.,

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A.T. system; and second, the supply by means of direct currents of medium E.M.F. used to charge accumulators arranged in series, the current being taken off the accumulators at the lower E.M.F. required for the lamps, and which I hereafter call the B.T. system.

All modern systems of distribution aim at the reduction of the first cost of the distributing plant—that is, of the charging and distributing mains, and all appliances belonging to them, such as transformers, regulating devices, street service boxes, house connections, &c., providing that such reductions shall not be at the expense of the efficiency of the system. It is difficult to fix an exact percentage of the loss allowable in the distributing plant, as so much depends on the length of the working hours, but I take it for granted that in no case must this loss exceed 10 per cent. I further take it for granted that the extreme variation allowable in the E.M.F. in the distributing mains must not exceed 4 per cent. So much has recently been written on the A.T. system that I will not lengthen this paper by describing it further than by stating that for purposes of my comparison I take the system as generally described by Mr. Kapp in his paper on transformers; or by Mr. Mackenzie, in his paper on transformers; and in an article in *Industries*, dated December 2nd, 1887, for which I believe Mr. Kapp is responsible, which gives very complete data on the first cost of an installation for 10,000 60-watt lamps, burnt simultaneously. On the other hand it is necessary for me here to briefly explain the B.T. system, which I propose to compare with it.

At Vienna the arrangements proposed by Mr. Monnier, and successfully carried out by myself and others, consist of charging from a central station groups of batteries of accumulators arranged in series. Each group of accumulators consists of 52 cells, giving the 100 volts required for the lamps, with a comfortable margin. The total E.M.F. required to charge the four groups of batteries in series varies from 430 volts, at the time the batteries are giving off work, to 480 volts, for the short time during which the charge is being completed. This includes the loss in the mains, generating stations being situated 1,400 yards from the distributing station. During five hours of lighting about two-thirds of the current comes direct from the dynamos; but during this time for short periods the demand of current often increases to such an extent that these proportions may be reversed, and the batteries supply two-thirds of the total. As this system has now been in use for upwards of nine months without any hitch or trouble whatever in connection with the electrical work, we may consider it proved there is no danger or difficulty in using currents of such high E.M.F. as 480 volts connected permanently to the distributing mains. The system may of course, be united with three or two groups only in series. An example of the last is the Central Station belonging to the Lemans Gas Company.

I now propose to commence my comparison of the two systems from four points of view:—

1st.—As to trustworthiness, steadiness, and quality of the lighting.

2nd.—As to the first cost of the plant, and

3rd.—As to working cost and maintenance.

4th.—As to the probable output, and hence maximum income, that can be safely obtained from the sale of electricity in each case.

I think it will be allowed that the commercial success of an electric light undertaking depends on these four points. I do not propose to dwell much on the first point. It is generally admitted that a system which uses storage must be superior to a system in which the continuity of the lighting depends entirely in moving machinery. There are many reasons why I should not make invidious comparisons on these points between existing systems. No one is prepared to dispute the fact that the A.T. systems hitherto installed have been remarkable for frequent interruptions in the lighting, whereas the reverse has been the case with the B.T. system. It remains for us to consider whether the undoubted great advantages which the B.T. system possesses in this respect is not purchased too dearly; and this matter will occupy the remainder of my Paper. The comparison I now make is for a system of electrical supply for London for 10,000 60-watt lamps, or their equivalent, simultaneously alight at hours of maximum demand,

1st. By alternating currents reduced from 2,000 volts to 60 volts by transformers.

2nd. By direct currents reduced from 440 volts to 110 volts by accumulators used as transformers.

Cost of Generating Station.—For the A.T. system I adopt the figures given by the writer in *Industries* on page 600 of the 2nd December, 1887. He therein proposes to provide for the 10,000-lamp plant dynamo power, including reserve equal to 865 kilowatts, and he fixes the price of those as £5,540. As regards motive power, I do not propose to take advantage of the writer's far too liberal estimate of its cost at £12 per indicated horse-power, but take it at the lower figure of £8. 12s. per indicated horse-power, thus reducing the cost to £12,500. I have estimated the cost of the building, chimney stack, water tanks, connections for water, drains, all measuring instruments and other accessories, at £11,000, thus bringing the total cost of the generating station of the A.T. system to £29,040. For the B.T. system I propose to provide plant of exactly similar type to that I have already supplied to Vienna. As I have said before, I propose that the dynamos should supply two-thirds of the maximum net output of 600 kilowatts. We therefore require about 448 kilowatts at the terminals of the accumulators; or, adding an 8¼ per cent. loss in the charging mains, 490 kilowatts in the generating station; 20 per cent. of reserve power will bring this up to 600 kilowatts, equal to 1,000 indicated horse-power. Such a plant may be conveniently divided into six sets of combined engines and dynamos, each of 100 kilowatts. Adopting the figure given above, viz., £8. 12s. per indicated horse-power, as the cost of the motive power, and that given by the writer in *Industries* at £8 per kilowatt, or £4,800 for the six sets of dynamos, and estimating that the cost of the building and other accessories, as before detailed, for the A.T. system will, in this case, be only £8,000, we find that £21,500 is the cost of the generating station for the B.T. system.

The cost of the alternating transformers is a very difficult matter to arrive at. The Grosvenor Gallery Company, I believe, with few exceptions, supplies every consumer with his own transformer; but Mr. Kapp, in his recent Paper, proposes to lay down a network of mains of much the same character as I use for the B.T. system, and to supply this network by a certain number of larger transformers, placed at frequent intervals in the network. It is difficult to see how any saving can be made by this arrangement. It will be noticed that, although it reduces the number of transformers, it introduces a new element of expense and difficulty, and that is, the providing of places to fix these large transformers. It may be that such places can easily be found, but my experience has been otherwise. It is not easy to find a place for any piece of machinery of a size between that which can conveniently be got into a surface box placed in the pavement not exceeding 1ft. in depth by 2ft. square, and a sub-station of the size I require for my battery transformers. In most cases there is no space either under the footways or under the street itself to form a water-tight chamber of sufficient cubic capacity for the purpose. Another difficulty and cause of additional expense which I think would tend to couterbalance any saving from the decreased number of transformers would be that the charging mains laid *to* the transformers, and the distributing mains *away* from the transformers, would have to be laid in the same trench or culvert, and this would be no small source of danger to those at work connecting houses on to the distributing mains. As I have not been able to obtain any reliable data on this modified system of Mr. Kapp's, I am obliged for the present to return to the system using one transformer for every two houses, and I think, for the reasons I have given above, the advocates of the A.T. system will not be able to make any great saving by adopting Mr. Kapp's suggestions.

TABLE 3.

COST OF 10,000-LIGHT OR 600-KILOWATT PLANT.

A.T.—Alternating Transformer Distribution.	£	B.T.—Accumulator Transformer Distribution.	£
Generating Station, Buildings, Chimney Shaft, Water Tanks, and General Fittings	11,000	Generating Station, Buildings, Chimney Stack, Water Tanks, and General Fittings	8,000
Dynamos and Exciters—865 Kilowatts, including spare sets, divided as convenient	5,540	Dynamos—600 Kilowatts, in 6 sets of 100 Kilowatts each	4,800
Motive Power, *i.e.*, Engines, Boilers, Steam and Feed Connections, Belts, &c, at £8. 12s. per I.H.-P. ..	12,470	Motive Power, *i.e.*, Engines, Boilers, Steam and Feed Connections, &c., at £8. 12s. per I.H.-P.	8,600
500 Transformers, *i.e.*, one to every pair of houses, at £15 each	7,500	4 Groups of Accumulators, in all 240 cells, in series, at £40 per cell, including Stands	9,600
2,000 yards Primary or Charging Main, exterior to area of supply, at £308 per 100 yards	6,160	2,000 yards Charging Main, at £306. 17s. 6d. per 100 yards (*see* Table 2)	6,137
20,000 yards Distributing Main, 50 mm. sectional area, at £91. 7s. (*see* Table 1)	14,270	20,000 yards Distributing Main, 161·25 mm. sectional area, at £100 12s. 6d. (*see* Table 2)	20,125
Regulating Gear	500	Regulating Gear	2,500
	£57,440		£59,762

Accumulators to be used as transformers must be of sufficient capacity to supply 200 kilowatts per hour for the hours during which the demand exceeds the 400 kilowatts supplied by the dynamos. The load curves shown in the diagram,* hanging before you, show that this period of maximum supply varies from about two hours in summer to four hours in winter. If I provide four

* We hope to give the diagram in our next issue.

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groups of accumulators, each of which has a total capacity of 259 kilowatts, or 1,000 kilowatts for the four, I provide for five hours of extreme demand, which is a condition of things extremely unlikely to occur, even in times of a fog. For it must be noted that the demand for light during a fog in the daytime (in a district partly residential and partly supplying shops) is of a far lighter nature than the demand from the same district during the ordinary hours of maximum lighting; the reason being that, during the hours of maximum lighting, not only the lamps in the basement, passages, and a certain portion of the dwelling rooms require to be simultaneously alight, but all upstair passages and a certain proportion of the bed rooms also require light. This is not the case during a fog; only the basement, lower passages, and living rooms take the light, and these to not nearly the same extent as they do in the evening. In order to meet a case of possible interruptions to the charging current, which might take place at the time of maximum demand, we require these accumulators to be capable of being discharged without damage to themselves, and at a fair rate of efficiency, at a rate not less than 650 kilowatts. It is this latter requirement that has so long delayed the introduction of accumulators as transformers. Up to a recent date far too much attention has been paid to the capacity, and too little to the rate of possible maximum discharge. This state of things has lately been remedied, and I am told there are several makers of accumulators who can supply them to fulfil the above-mentioned conditions, and at the reasonable priced named by me in my estimate. It must be remembered that such accidental stoppages of the lighting current as are likely to take place would not probably last for more than a few minutes, that is to say, if due provision has been made for spare machinery, and if the arrangements for working the machines parallel and interchangeable have been properly carried out. Time will not permit me in the course of this Paper to describe fully the switch-board and regulating arrangements necessary for the B.T. system. These require to be so arranged that the loss due to the difference of E.M.F. between the charge and discharge of the batteries may be as small as possible. It is quite possible to work the batteries parallel to the charging current during the hours of maximum demand with little or no loss from this cause, the loss being confined to the hours when the batteries are being finally filled up before the engines are stopped. The sub-stations, which contain the accumulator transformers, can in almost every case be placed on "mews" property, and I have ascertained from accurate inquiry that there is no difficulty in obtaining accommodation for them in such property, with but few exceptions, within 300 yards radius of the houses to be supplied. In each case the sub-station consists of a battery room and living room for the man in charge. The plant in each sub-station consists of the batteries themselves, the regulating appliances above-mentioned, voltmeters and district meters as may be thought necessary.

Distribution.—In the case of the A.T. system the charging mains, as far as they lie within the area of supply, are in reality the distributing mains; in other words, we require 20,000 yards of distributing mains to reach the houses. I am informed that the section usually employed for the distributing mains of these 2,000-volt circuits, when the transformers are placed in parallel, is 50 millimetres cross section, or 19 strand, No. 15 B.W.G. From Table No. 1 you will see that this costs £71. 7s. per 100 yards. I have not worked out the cost of so small a section laid on my own plan in the culverts, but it would certainly not be less than £96 per 100 yards. However, adopting the lower figure, the distributing main will cost £14,270. The writer in *Industries* says that 720 kilowatts will have to be generated at the generating station for transmission to the area of supply; dividing this by 2,000 volts, we get 360 amperes as the current in the charging main. Adopting Prof. Forbes' tables for calculating the section of the conductor, we find that it ought to be about 645 millimetres, and if laid in the cable form, as in Table 1, but without surface boxes, would cost about £308 per 100 yards, or in all £6,160. It will be asked why I do not give to these charging mains the advantage of the somewhat lower cost of laying them as bare copper, as in Table 2, but I do not think it would be safe to leave conductors carrying currents at 2,000 volts thus unprotected in the culverts, as the risk to workmen employed on the district system would be too great, to which must be added the great risk to the consumers, of making an accidental contact from the charging to the distributing mains. I should here remark, that the very confident tone adopted by many supporters of the A.T. system rests on very slender foundations; they appear to forget that the great success obtained in America has been with overhead wires used as the primary or charging mains. We all know what a high degree of insulation is possible with overhead wires; we also know that extreme difficulty has been met with in America in all attempts to obtain sufficient insulation for wires carrying currents of high E.M.F. when laid underground. As a matter of fact, failure has been the rule, and success the exception. I believe that the difficulties of the A.T. system will commence when the contractors have to guarantee a perfect insulation with underground cables carrying currents at an E.M.F. of 2,000 volts. Let those who think otherwise read Prof. Elihu Thomson's remarks at the recent electric light convention in America. He used the following words :—"Distribution of current to groups of incandescent lamps, arc light, or other high potential lines should always be undertaken with great care, and it is thought that such work should only be undertaken when exceptionally favourable conditions for avoiding accidental leakages exist, especially should the potential of the line at the dynamo exceed 1,500 volts, or an amount which would sustain 30 arc lamps in series. One of the important elements of safety in such installations is simplicity and ease of inspection of the wiring, and no concealed wires should be used in them." Again, he says, "for house to house and general incandescent lighting, where the distances from the station are not too great, the direct low-potential systems possess most of the advantages, the difficulties of leakage from the defective insulation being of course at a minimum; but where the distances are so great as to make the required outlay for copper in the conductors practically prohibit the extension of the system, a transformer or converter system, if of good design and economy, may be made to yield excellent results." Now, the writer of these words is one of the greatest authorities on electric lighting matters in America, and a strong supporter of the A.T. system. I think, therefore, that I have not dwelt too strongly on the grave difficulties likely to be encountered by those who so glibly talk of laying underground charging mains, carrying currents at 2,000 volts potential, and I think that in all probability the additional precautions that will have to be taken to avoid failure of the insulation will be so expensive as to bring the total cost of the 22,000 yards up to practically the same sum as is required for the 2,000 yards of charging main, and 20,000 yards of distributing mains of the B.T. system, for which no special precautions are necessary.

I work out the cost of the latter as follows :—I use throughout bare copper mains of ·25 inch section for the distributing mains; that is to say, for the 20,000 yards at the rate given in Table 2 of £100 12s. 6d. per 100 yards, they will cost £20,125. The charging main will have to carry 910 amperes, and the extreme loss allowable being 8·25 per cent., its resistance must be 0·04 ohms. The double conductor will weigh about 45 tons: this can be laid as in Table 2, in brickwork, in cement culvert, at the rate of £306. 17s. 6d. per 100 yards, or £6,137. 10s. I have put down an item of £500 for the regulating gear for the A.T. system, and another one of £2,500 for the regulating gear for the B.T. system. The totals thus arrived at, and which you see before you on the wall, are £57,440 as the total cost of the A.T. system, and £59,762 for the B.T. system. These figures appear high, but I cannot see how they can be reduced, unless under very exceptional circumstances. In both cases a very large portion of the cost lies in the distributing plant, and of this, as you will gather from my Tables 1 and 2, the copper plays but an insignificant part, the real heavy charges being those inseparably connected with underground cables, viz., the cost of insulation and those connected with disturbing and replacing the surface of the streets.

(To be continued.)

THE RADIOGRAPH.*

BY M. LOUIS OLIVER.

The method suggested by the author some three years ago of timing the exposure of photographic plates by means of the radiometer has been much used by photographers both in France and in other countries. Of course, for the so-called instantaneous process the method is not required, but for slower exposures it is very useful. With the same objective, the same stop, and the same plates, a period of exposure determined by counting the same number of revolutions of the radiometer always gives the same results. Contrary to what might, perhaps, have been supposed, the accuracy of the method is not at all affected by the variation in the composition of the light at different hours of the day.

Thinking that it would be of interest to render this regulation automatic, I have been led to devise the apparatus described below, which I propose to call the Radiograph. Its function is to produce an automatic record of the total amount of light which falls upon its vanes, the record having reference *both to duration and to intensity.* The apparatus consists essentially of a radiometer which at every rotation closes an

* Abstracted from the *Comptes Rendus*, March 19th, 1888.

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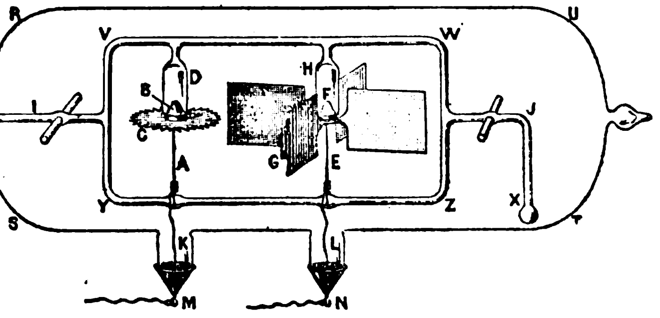
electric circuit, and through the medium of a relay moves a needle step by step upon a dial.

The mode of action is easily understood. At every rotation of the vane the projection G makes contact with the aluminium wheel and closes a circuit through K and L. A wheel is used for the contact solely in order to avoid checking the rotation of the vane. The current passing through this circuit is very small and is only used to close a relay contact, bringing into action a more powerful battery, by means of which a needle is caused to traverse a dial step by step, the position of the needle always corresponding to the numbers of revolutions of the radiometer. For photographic purposes it is easy to arrange a third circuit by which the shutter is closed when the needle arrives at any predetermined position.



R S T U is an envelope of glass in which a high vacuum exists.
A vertical steel needle supporting the cap B.
C light aluminium toothed wheel.
E vertical steel needle supporting the cap F upon which the radiometer vanes are mounted.
G projection on vane which turns wheel C.
V Y Z W supporting frame made of glass.
D and H glass tubes to keep caps A and B in position.
I J X are also portions of the glass framework.
K and L electrodes fixed to the needle A and E, and making contact through the mercury cups with wires M and N.

It is anticipated that the apparatus will sometimes prove of value for investigations in the various physical and chemical problems.

RULES AND REGULATIONS FOR THE PREVENTION OF FIRE RISKS ARISING FROM ELECTRIC LIGHTING.

ISSUED BY THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

Revised and Remodelled from the Rules issued by the Society in 1883, and from other sources of information, both home and foreign, and recommended by the Council in accordance with the Report of the Committee appointed by them to consider the subject.

Members of the Committee:—Prof. W. G. Adams, F.R.S., past president; Prof. W. E. Ayrton, F.R.S., vice-president; Sir Charles T. Bright, past president; E. B. Bright; R. E. Crompton; W. Crookes, F.R.S., vice-president; Dr. J. A. Fleming, M.A.; Prof. G. Forbes, F.R.SS. (L. and E); Prof. G. C. Foster, F.R.S., past president; Edward Graves, president; J. E H. Gordon, B.A.; Dr. J. Hopkinson, F.R.S., vice-president; Prof. D. E. Hughes, F.R.S., past president; W. H. Massey; W. H. Preece, F.R.S., past president; Sir David Salomons, Bart., M.A.; Alexander Siemens, vice-president; C. E. Spagnoletti, past president; James N. Shoolbred, B.A.; Augustus Stroh; Sir William Thomson, F.R.SS. (L. and E.), past president; Major-General C. E. Webber, C.B., (Ret) R.E., past president.

These general rules are drawn up with the object of reducing to a minimum, in the case of the electric light, those risks of fire which are inherent to every system of artificial illumination, and also for the guidance of those who possess, and those who contemplate having, electric lighting apparatus on their premises.

It is to be understood these general rules are not intended to supersede any detailed rules which fire offices may issue for their own protection.

It would therefore be desirable that before the electric light is used, notice should be sent to the fire office in which the building is insured, in order that an opportunity may be given for inspecting the installation.

The chief difficulties which beset the electrical engineer are internal and invisible, and they can only be effectually guarded against by testing with special apparatus and electric currents; they arise from leakage and from bad connections and joints, which lead to waste of energy and the production of heat to a dangerous extent.

In addition, the difficulties arising out of defective and inefficient apparatus are numerous; they must be understood and guarded against.

The necessity cannot be too strongly urged for guarding against the presence of moisture, which leads to loss of current and to the destruction of the conductors and apparatus by corrosion and otherwise.

Injudicious connections of any part of the circuit with the "earth" tend to magnify every other source of difficulty and danger.

Many of the dangers in the application of electricity arise from ignorance and inexperience on the part of those who supply and fit up inadequate plant, and frequently from injudicious economy on the part of the user.

The greatest element of safety is, therefore, the employment of skilled and experienced electrical engineers to specify the method in which the work is to be done and the quality of the materials to be employed, and to supervise the execution of the work.

CONDUCTORS.

1. They must have a sectional area and conductivity so proportioned to the work they have to do that, if double the current proposed is sent through them, the temperature of such conductors shall not exceed 150° F.

2. The conductors, or their casings, should be placed in sight, if possible; and they should always be as accessible as circumstances will permit.

3. Within buildings they should all be insulated; and this rule applies equally to all conductors and parts of fittings which may have to be handled.

4. Whatever insulating material is employed, it should not soften until a temperature of 170° F. has been reached, and in all cases the material must be damp-proof.

5. When leads pass through roofs, floors, walls, or partitions, and where they cross or are liable to touch metallic substances, such as bell wires, iron girders, or pipes, they should be thoroughly protected by suitable additional covering; and where they are liable to abrasion from any cause, or to the depredations of rats or mice, they should be encased in some suitable hard material.

6. In the case of portable fittings with which flexible leads are used, special precautions must be taken.

7. Conductors should be kept as far apart as circumstances will permit, the spacing between them being governed by their potential difference.

8. When conductors are carried in very inflammable structures, precautions should be taken to isolate them therefrom.

9. Conductors which are protected on the outside by lead or metallic armour of any kind require the greatest care in fixing, on account of the large conducting surface which would become connected to the core in the event of metallic contact between them.

10. In cases where conductors pass into a building, from one building to another, or from one room to another, precautions should be taken to prevent the possibility of fire or water passing along the course of the conductors.

11. All joints must be mechanically and electrically perfect, to prevent heat being generated at these points. When soldering fluids are used in making joints, the latter should be carefully washed and dried before insulation is applied.

12. Under all circumstances complete metallic circuits must be employed. Gas and water pipes must never form part of the circuit, as their joints are rarely electrically good, and therefore become a source of danger.

13. Overhead conductors, whether passing over or attached

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to buildings, must be insulated at their points of support. Precautions must be taken to obviate all risk of short-circuiting where they are likely to touch a building or other overhead conductors and wires, either by their own falling or by being fallen upon by other conductors.

14. In the case of overhead wires, every main should have a lightning protector at each point where it enters or branches into a building.

15. Metal fastenings for fixing conductors should be avoided; but, when unavoidable, some additional covering should protect the conductor from mechanical injury at such fixing points.

16. The insulation of a system of distribution should be such that the greatest leakage from any conductor to earth (and, in case of parallel working, from one conductor to the other, when all branches are switched on, but the lamps, motors, &c., removed) does not exceed one five-thousandth part of the total current intended for the supply of the said lamps, motors, &c., the test being made at the usual working electromotive force.

17. It will often be found a great convenience and assistance in the prevention of accidents if the positive lead be coloured differently to the negative, or made otherwise distinguishable.

SWITCHES.

18. Every switch or commutator should be of such construction as to comply with the following condition, namely, that when the handle is moved or turned to and from the positions of "on" and "off," it is impossible for it to remain in any intermediate position, or to permit of a permanent arc, or heating.

19. The handles of every switch must be completely insulated from the circuit.

20. The main switches of a building should be placed as near as possible to the point of entrance of the conductors, or to the generators of the current if they are within the building itself. Switches should be provided on both leads.

21. Switch-boards should bear clear instructions for their use by the inexperienced.

ELECTRICAL FITTINGS GENERALLY.

22. Switches, commutators, resistances, bare connections, lamps, &c., must be mounted on incombustible bases. Cut-outs mounted on bases of wood rendered uninflammable are admissible. Vulcanite bases are undesirable in damp situations. The cracking of porcelain and earthenware fittings is a source of danger which can be avoided by precautions in fixing.

CUT-OUTS.

23. All circuits should be protected with cut-outs; and all leads from the mains, or small conductors from larger ones, must be fitted with cut-outs at their branching points.

24. Where fusible cut-outs are used, the section should be so situated within its frame that the fused metal cannot fall where it may cause a "short-circuit" or an ignition.

25. For all main conductors a cut-out should be provided for both the "flow" and "return," and the two fusible sections must not be in the same compartment.

26. The flexible leads of portable fittings must in all cases be protected by cut-outs at their fixed points of connection.

ARC LAMPS.

27. Arc lamps must always be guarded by lanterns or netted globes, so as to prevent danger from ascending sparks and from falling glass and incandescent pieces of carbon.

28. All parts of the lamps and lanterns which are liable to be handled (except by the persons employed to trim them) should be insulated.

THE DYNAMO.

29. The armatures and field magnet coils should be thoroughly insulated. Dynamos should always be fixed in dry places, and they must not be exposed to dust flyings or other industrial waste products carried in suspension in the air. They should not be permitted in the working rooms of mills, where the liability to such dangers exists, or where any inflammable manufactures are carried on or inflammable materials are stored.

30. Motors should be subject to the same conditions; but when it is necessary to use them in positions such as those above referred to, they must be securely cased in, such cases having a non-combustible lining.

BATTERIES.

31. Both primary and secondary batteries should be placed and used under the same precautions as prescribed for dynamos; and the room in which they are placed should be well ventilated. The batteries themselves must be well insulated.

TRANSFORMERS.

32. When these are used to transform either direct or alternating currents of high electromotive force—that is, from or to an electromotive force of, say, 200 volts—they, together with their switches and cut-outs, must be placed in a fire and moisture proof structure, preferably outside the building for which they are required. No part of such apparatus should be accessible except to the person in charge of their maintenance.

33. In all cases conductors conveying currents of high electromotive force inside buildings must be specially and exceptionally insulated, cased in, and the casing made fireproof.

34. The positive and negative terminals connected to such conductors should not be permitted to be nearer each other than 12 inches.

35. Transformers which, under normal conditions of load, heat above 150° F. should not be permitted to remain in use.

36. Transformers should be so constructed that under no circumstances whatever should a contact between the primary and secondary coils lead the high E M.F. into the building.

MAINTENANCE.

37. The value of frequently testing and inspecting the apparatus and circuits cannot be too strongly urged as a precaution against fire. Records should be kept of all tests, so that any gradual deterioration of the system may be detected.

38. Cleanliness of all parts of the apparatus and fittings is essential to good maintenance.

39. No repairs or alterations must be made when the current is "on."

All the above rules, for the reduction to a minimum of the risks from fire, are also applicable in principle to installations of electricity for other uses than that of lighting; they also include precautions necessary to avoid risk of injury to persons, whether the conductors and apparatus are situated inside or outside a building.

THE LIGHTING OF THE UNION BANK OF LONDON AND RIVER PLATE BANK.

We have recently inspected an installation at the head offices of the above bank which has been put in by Messrs. Verity Bros., to the design of Messrs. Drake and Gorham. In the sub-basement are two 9 horse-power Otto engines driving two Elwell-Parker dynamos, inverted B type, 12 units, running at 750 revolutions. The engines exhaust into pits sunk in the ground, which has a perfect silencing effect, no sound from the exhaust being audible even when standing on the next floor directly over the engine room. Two sets of accumulators, of 53 Elwell-Parker L 23 type, are arranged in a small cellar in Princes-street, and a Blackman air propeller driven by an electric motor ventilates both engine and battery room at the same time. The switch-board is fitted with Drake and Gorham ammeters and ring contact switches, and is divided into two sections, A and B. The lamps throughout the building are arranged so that in each department one-half the lamps (where possible alternate ones) are fed from section A, and the other half from B. The two

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sections have nominally each their own dynamo and battery, but the boards allow of any desired combination between the two machines, batteries, and sections. All the fuses are on the switch-boards. As it is necessary to provide a certain number of lamps running all night for cleaning, &c., a special arrangement is provided for introducing into the circuit a Cunnynghame cut-out which breaks the main circuit when more than a certain total number of lamps are on, and which cannot re-set until the same are switched off, thus preventing waste after hours. One of Messrs. Drake and Gorham's excess indicators is arranged in each battery circuit, and rings a bell when the proper charging current is exceeded. Passing to the lighting itself, there are altogether some 330 lamps fitted, most of them being half frosted and half plain, which has been found the most economical way of reducing glare. The standards on the desks are of special design, and are very neat and effective. The shade of the lamps is supported by two arms, each carrying a gas burner in case it may be wanted. Where the leads have to be brought through tubes in the fittings special precautions have been taken to avoid any danger from short circuits.

On leaving the Union we then went to the River Plate Bank, to look over a battery there which has been in constant use without any repairs for about eighteen months. This covering two winters' work is a good test, and it speaks well for the secondary battery of the future that in a careful search through the whole set we were only able to find one cell showing even a trace of buckling, and that only to a very slight degree. From the appearance of the cells after two winters' work we should put the life of the positive plates at four years as a minimum, and with cells made now, with another year's experience, we may in reason expect to get longer life still.

BOOKS, &c., RECEIVED.

"Phénomènes Electriques de l'Atmosphere." Par Gaston Planté. (Paris: J. B. Baillière et Fils. 1888.)

Journal of the Society of Telegraph-Engineers and Electricians. No. 71, Vol. XVII. (London: E. and F. Spon.)

"Rules and Regulations Recommended for the Prevention of Fire Risks from Electric Lighting." The Society of Telegraph-Engineers and Electricians. (London: E. and F. Spon.)

"Domestic Electrical Supplies." Second Edition. (Woodhouse and Rawson Electric Supply Company, Limited.)

"Syllabus of the Chemistry and Engineering Course at the Massachusetts Institute of Technology." (Boston: Alfred Mudge and Son).

"La Pile Automatique 'O'Keenan.'" (MM. Mors, Constructeurs, à Paris.)

ELECTRICAL POWER STORAGE COMPANY (Limited).

Report of the Directors to be presented to the shareholders at the seventh ordinary general meeting, to be held on Thursday, the 19th inst., at Winchester House, Old Broad-street, E.C., at 12:30 p.m.:—

The gross profit for the year is £11,875 1s., derived from the trading of the Company and from royalties and receipts both at home and from the Continent. The Directors have made provision for depreciation of plant, machinery, buildings and doubtful debts, by writing off the sum of £1,569. 1s. 7d.

The above amount, added to the balance to the credit of profit and loss from last year, with the small item of transfer fees, makes the sum of £25,418. 12s. 6d., and after deducting the expenditure of the year and the amount provided for depreciation, &c., a balance remains to the credit of this account of £10,793. 6s. 11d., out of which the Directors propose to place £4,000 to the credit of the reserve fund, leaving a balance of £6.793. 6s. 11d. to be carried forward.

In addition to the above depreciation and reserve a sum of £1,000 has been written off patents account, lessening the gross profit of the year by that amount, while a small increase occurs in this account through the purchase of some other patent interest which it was considered advisable to acquire, but no change in the valuation of the patent interests has been made.

Never before have so many inquiries from all parts of the country been received as during the last two or three months, or have so many negotiations been in progress in connection with the various uses to which the E.P.S. storage batteries are applicable. Central station lighting, tramcar, omnibus and boat propulsion, train lighting, &c.—in each of these branches the inquiries indicate a coming activity in electrical work of a special kind, such as justifies the Directors in confidently looking forward to a large increase in the demand for storage batteries during the current year.

It is much to be regretted that the electrical industry is still fettered by the Act of 1882, but the Bill of Lord Thurlow has been again introduced in the House of Lords, and there is such a concurrence of opinion in favour of an alteration of the Act, that it may be considered tolerably certain that this session will see the much needed changes become law.

The Directors are glad to state that the serious litigation on the Continent is at an end, the Company having succeeded in enforcing the recognition of its rights. Arrangements have recently been completed, by which the manufacture of the E.P.S. battery will be carried on in France, Austria, Hungary and Russia, under payment of royalties, and applications from other countries are now being considered.

In the United States the Electrical Accumulator Company is making very satisfactory progress, and the immediate prospects in the most important branches of that Company's business are of a like character to those in this country.

The Directors are vigilant in protecting the property of the shareholders against all assailants, and they have deemed it necessary to commence an action for infringement of the Company's patents against the Union Electrical Power and Light Company (Limited).

The Company has had its share of permanent installation work, several banks, commercial houses, and private residences in different parts of the country having been satisfactorily lighted. A large amount of temporary lighting has also been carried out.

The application of storage batteries to ship lighting has received more support during the year, and the lighting of railway trains by electricity from storage batteries is receiving considerable attention from the large railway companies, business having been done with several of the leading lines.

A new branch of business—omnibus and carriage lighting—has been initiated with good promise.

A further development of the uses of storage batteries has been made by the Exchange Telegraph Company, who have replaced 2,000 primary batteries with 210 storage cells for working their telegraphic system. These batteries are charged for about a quarter of an hour every day by means of an engine and dynamo, driven from the Hydraulic Company's mains, and after six months' trial they have been pronounced a perfect success.

In motive power a moderate business has been done. Tramcar and boat propulsion are gradually developing, and among other interesting applications of E.P.S. batteries may be mentioned, an electrically driven torpedo, and the experiments in connection with Mr. Eric Bruce's military balloon signalling.

Several important improvements have recently been made in the Company's special manufactures. The form of E.P.S battery known as the "1888" type is considered by the electrical profession as being a great improvement. In this new type the whole of the plates are joined together by metallic bands, so that the battery forms a substantial and rigid set of plates, and the original troubles of short-circuiting and local action have been removed.

A gold medal for an exhibit of batteries and apparatus at the Jubilee Exhibition of the French Railways was awarded to the Company at Paris.

Considerable progress has been made during the year in the perfecting of the arrangements for the application of storage batteries to the public supply of electricity, a pamphlet having been issued by the Company comparing the alternating-current system with the storage-battery system. This pamphlet has appracted much notice, and the statements made in it have been well received, and many of the opponents of the storage system have thought fit to modify their former views.

The question of distribution by continuous-current transformers, which can readily be worked with storage batteries, has also been under the consideration of the Directors, and the Company possesses inventions which it is thought may be of value in the control of the use of storage with this new type of transformer.

The retiring Directors are Mr. Frederick Green and Mr. John Scudamore Sellon, who, being eligible, offer themselves for re-election.

The auditors, Messrs. Deloitte, Dever, Griffiths and Co., also offer themselves for re-election.

JUDGMENT OF THE SUPREME COURT OF THE UNITED STATES IN THE TELEPHONE APPEALS.

(Continued from page 610.)

ALLEGED ANTICIPATION BY DANIEL DRAWBAUGH.

Another alleged anticipation is that of Daniel Drawbaugh. Bell got his patent March 7, 1876, and the fortunate accident which led to his discovery occurred June 2nd, 1875. Active litigation to enforce the patent rights was begun by his company on the 12th of September, 1878, with a suit in the Circuit Court of the United States for the district of Massachusetts, against Peter A. Dowd. This suit was defended by the Western Union Telegraph Company, and vigorously contested. The answer was filed November 4, 1878, setting up alleged anticipation by Gray, Edison, Dolbear and others. The record fills 1,200 printed pages; but before a decision was reached the case was compromised, and a decree entered by consent. The litigation ended some time in the latter part of year 1879. The last deposition was taken on the 19th of September in that year.

The next contested suit was brought in the same court, on the 28th of July, 1880, against Albert Spencer and others. An answer was filed in

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this case September 6, 1880, and depositions afterwards taken, some of those in the Dowd suit being used in this by stipulation. On the 27th of June, 1881, a decision was announced by Judge Lowell, sustaining the patent, upon which a decree was entered.

On the 14th of November, 1879, Mr. A. G. Tisdel filed in the Patent Office an application for a patent for a new and useful improvement in speaking telephones. On the 18th of November, 1879, Frank A. Klemm also filed an application for a patent for a new and useful improvement in telephone transmitters. These inventions were transferred by assignment to Ernest Marx and Frank A. Klemm, of New York city; — Levy, of Cincinnati; and Simon Wolf, of Washington. On the 6th of March, 1880, these parties entered into a mutual agreement, to the effect that each and all of their interests in said improvements and inventions, and the letters patent to be issued therefor, should be merged and consolidated as the common stock in a corporate body under the laws either of the State of Ohio or New York, or the general laws of the United States, relating to the formation of corporations in the district of Columbia, or in such other States and territories as might be found necessary hereafter. This agreement was recorded in the Patent Office March 10, 1880.

On the 6th of May, 1880, Edgar W. Chellis, a merchant, of Harrisburg, Pennsylvania, H. W. Jacobs, a lawyer of the same place, and Lysander Hill, a lawyer then residing in Washington, in the district of Columbia, made an arrangement with Daniel Drawbaugh, by which they were to become jointly interested with him in his alleged telephone inventions, each to have a quarter interest. Nothing was paid for this, but each of the parties was to have one quarter of anything that should be realised from the enterprise. On the 24th of May, 1880, Simon Wolf, one of the parties interested in the Klemm and Tisdel inventions, visited Harrisburg on business with Chellis in reference to telephone matters. On the 18th of May, six days before this visit, a patent was issued to Wolf and his associates upon the invention of Tisdel. While Wolf was in Harrisburg, negotiations were begun by Chellis for the transfer of the Drawbaugh inventions, and these negotiations resulted in a conditional contract on the 22nd of June, by reason of which Chellis, Jacobs, Hill and Drawbaugh went to Washington. There on the 21st July, 1880, Drawbaugh, claiming to have invented "new and useful improvements in the transmission of vocal speech, and the apparatus to be used for those purposes, for which I am about to make application for letters patent of the United States," assigned to Klemm, Marx, Wolf and Levy, the full and exclusive right to the said inventions as fully set forth and described "in the specifications prepared and executed by me, dated 21st July, 1880, preparatory to obtaining letters patent of the United States therefore." He at the same time and by the same instrument authorised and requested the Commissioner of Patents to issue the patent to his assignees, each as assignee of one quarter part. The specification referred to in the assignment has not been put in evidence in any of the cases. In the course of taking the testimony it was called for by the Bell Company, but the counsel for the opposite party declined to produce either the original or a copy from the Patent Office. The assignment was recorded in the Patent Office July 22nd, 1880, and in the official Digest of Assignments the following notice appears:—

About to make application. Specification dated July 21st, 1880.

On the morning of July 22nd, 1880, the following article appeared in the *Cincinnati Commercial*, a newspaper printed at Cincinnati, Ohio:—

"TELEPHONE COMBINATION.

"Special to the *Cincinnati Commercial.*

"Washington, D. C., July 21.

"An application for a patent was filed to-day, that in consequence of its vastness of interest, as well as wealth of prospect, renders it a subject of national interest. A company of leading business men has been formed that has bought up all the telephone patents antedating those now in use, and known as the Bell, Gray, and Edison patents. The company is composed of leading business men from all parts of the country, Cincinnati being largely represented and interested. The cash capital of the company is $5,000,000, with head-quarters in New York, and in about 60 days they will open up the telephone, which will certainly result in the driving out of all telephones in the market, save the ones they hold, or else in compelling the Gray, Bell and Edison lines to pay the new company a munificent royalty. It appears from the testimony now on file and in the possession of the new company, which is conclusive and exhaustive, that the inventor of the telephone is a poor mechanic, living near Harrisburg, Pa., named Daniel Drawbaugh. Owing to his poverty he was unable to push his patent on the market. The new company have secured and are sole possessors of this invention, antedating those now in use. They are also owners of four patents for telephones issued to Mr. Klemm, of New York. A large number of capitalists were here to-day to see the filing of the application, and they assert, with a positiveness that is almost convincing, that it will not be long till they have entire charge of the telephones, not only in this country but in the world, and that they will be able to establish lines by which messages can be transmitted for almost a song.

"Mr. Lipman Levy, of the law firm of Moulton, Johnson and Levy, of Cincinnati, was here to-day in the interest of the Cincinnati parties, who, as already stated, are among the most prominent financial men of our city."

Afterwards, on the 23rd of August, 1880, the following appeared in the *Journal of Commerce*, a newspaper printed in the City of New York:—

"*A New Telephone Company.*—A company has recently been formed in this city with a capital of $5,000,000 for the purpose of manufacturing telephones. The company is to be known as the People's Telephone Company, and a number of leading capitalists in this city and Cincinnati are interested in it. The telephones are to be manufactured under the patents of Frank A. Klemm and Abner G. Tisdel, and the application for patents of Daniel Drawbaugh, of Eberly's Mills, Cumberland County, Pa., filed July 21st 1880. It is claimed by those interested in the new enterprise that Drawbaugh is really the inventor of the telephone, and had completed one years before Prof. Bell or anyone else had manufactured one. He was, however, in very humble circumstances, and his neighbours, who knew of his experiments, looked upon him as a harmless lunatic. He continued improving his original telephone, and it is claimed that the one which the new company proposes to furnish is superior to any now in use. The company has fitted up a factory in Brooklyn, and in three months will be prepared to supply 1,000 of the new telephones. As soon as operations are actively commenced, it is expected that legal proceedings will be begun against the new company by the Gold and Stock Telegraph Company, which holds most of the existing patents, and a long and interesting legal fight is anticipated."

On the 30th of August, 1880, the People's Telephone Company was incorporated under the general laws of New York, with an authorised capital stock of $5,000,000, for manufacturing, constructing, owning, furnishing, letting and selling telephones and the apparatus used therewith under the inventions and patents of Abner G. Tisdel, Frank A. Klemm, Daniel Drawbaugh, and other inventions and patents which may hereafter be assigned to that company. On the 4th of September, 1880, Klemm, Loth, Marx and Wolf, in consideration of $4,999,550, represented by 99,991 shares of stock, assigned and transferred to that company all their interests in the Klemm, Tisdel and Drawbaugh inventions, those of Drawbaugh being described as "inventions in telephones made by Daniel Drawbaugh, of Eberly's Mills, Cumberland County, Pennsylvania, for which applications for patents were made on or about the 21st of July, 1880, and which were assigned to us on the 31st of July, 1880, as more particularly appears in the deed of assignment, recorded in the United States Patent Office." For the assignment from Drawbaugh to Klemm, Marx, Loth and Wolf, $20,000 was paid in money to Chellis, Jacobs and Hill, and they were allowed to have a certain amount of the stock of the proposed corporation then formed. What amount they actually got, Chellis, who was sworn as a witness in the case, declined to state, but he admitted it was large.

At this time and in this way the attention of the general public was called, for the first time, to the fact that Drawbaugh claimed to have anticipated Bell in the discovery of the telephone. Bell's success had been proclaimed more than four years before, at the Centennial Exhibition in Philadelphia. In the meantime inventions in aid of his discovery had been multiplied. According to the testimony of Park Benjamin, more than 100 patents had been issued and indexed under the word "telephone," and numerous interferences had been declared and considered by the Patent Office. Gray, Edison, Dolbear, and others had either claimed for themselves, or others had claimed for them, priority of invention and discovery, and Bell had thus far been sustained as against them all. Blake had perfected his microphone apparatus, and Bell's patent had become a great commercial success. The People's Company either began or threatened to begin operations under its charter, and on the 20th of October, 1880, the Bell Company brought suit against it in the Circuit Court of the United States for the Southern District of New York, to prevent any infringement of the Bell patent. In the Bill it was alleged that "telephone exchanges now exist in more than 275 towns and cities of the United States, and in every State thereof, and exist in substantially every city having more than 15,000 inhabitants, and in many smaller places. . . . . . That there are now in use more than 100,000 electric speaking telephones, licensed by and paying royalty to the Bell Company; that the owners of the Bell patents, and those who now are or heretofore have been licensees of them, have devoted great time and attention and large sums of money to the development of the telephone and the introduction thereof into extensive use, and to the proper construction of the most suitable telephone lines and systems, and telephonic appliances, and have constructed many thousand miles of telephone lines for use with telephones owned by the Bell Company, and licensed by it for such use; and nothing which the defendants, or F. A. Klemm, A. G. Tisdel or Daniel Drawbaugh have done, has contributed in any substantial way to the development of the telephone or the introduction thereof into use."

The Bill then avers that Klemm, Marx, Levy and Wolf, having become owners of these inventions, and having heard that Drawbaugh claimed that "he had made some experiments relating to electric speaking telephones (which experiments, if made, were incomplete, imperfect, unfruitful, and long before abandoned), entered into an arrangement with him to set up and claim that he was the first inventor of the electric speaking telephone, and to make application for a patent therefor; and that thereafter alleging and pretending that said Drawbaugh was the original and first inventor of the electric speaking telephone, and that electric speaking telephones had not before such application been in public use or on sale for more than two years with the knowledge and consent of Drawbaugh, did on or about the 21st of July, 1880, induce him to make and cause to be filed in the Patent Office of the United States an application for a patent, to issue to them as the assignees of the said Drawbaugh as the first and original inventor of the electric speaking telephone."

It was then further alleged that if Drawbaugh had ever made his pretended inventions they had not been, by him or any one claiming under him, introduced into public use, and "that knowledge thereof has been withheld from your orators and the public, except so far as they have been disclosed within the three months last past by certain newspaper publications."

To this bill the People's Company filed an answer in December, 1880, or January, 1881; the record does not show the precise date. In this

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answer it was said that Drawbaugh was the original and first inventor and discoverer of the art of communicating articulate speech between distant places by voltaic and magneto electricity, and that long prior to the alleged invention by Bell, Gray, and Edison, he then and now residing at Eberly's Mills, constructed an apparatus which was a practical working electric speaking telephone, at said Eberly's Mills, and exhibited the same in successful operation to a great number of other persons residing in his vicinity and elsewhere; and that his telephones as then constructed and operated contained all the material and substantial parts and inventions patented in the patents of Bell, and also other important and valuable inventions in electric and magneto telephones, and were actually used for transmitting articulate vocal sounds and speech between distant points by means of electric currents; that he had the original instrument which he used and had exhibited to many others long prior to the said alleged inventions of Bell or either of them; that they are still in existence and capable of successful and practical use, and are identified by a large number of persons who personally witnessed their practical operation and use in the years 1870, 1871, 1872, 1873 and 1874, and several years prior and subsequent thereto; that certainly more than fifty and probably not less than one hundred persons, or even more, were cognisant of said Drawbaugh's invention and use of said telephone, and of his claiming to be the original and first inventor thereof prior to the alleged inventions of said Bell or either of them; that said Drawbaugh for more than ten years prior to the year 1880 was miserably poor, in debt, with a large and helpless family dependent upon his daily labour, and was from that cause alone utterly unable to patent his invention or caveat it, or manufacture and introduce it on the market; that said Drawbaugh never abandoned the said invention nor acknowledged the claim of any other person or persons thereto, but always persisted in his claims and intended to patent it as soon as he could procure the necessary means therefor. That said Drawbaugh never acquiesced in the public use of said Bell, Gray, Edison, Blake, or other telephones, nor in the claims of the alleged inventors nor gave his consent to such use.

It is then said that Drawbaugh, after finding by experiment that his invention was capable of successful working, conceived that its range and capacity for usefulness to the public might be greatly enlarged, and that many improvements of great value might be made and added to it, which without departing from its principle, might increase its value to himself and to the public; and therefore set himself to work to discover and invent such improvements; that he discovered and invented some such improvements prior to any alleged invention by the said Bell; and then, notwithstanding his embarrassed and impoverished pecuniary condition, and his utter want of proper mechanical tools, materials and appliances to conduct such work, he laboured with all reasonable diligence to perfect and adapt his said improvements, and did finally, in due exercise of such reasonable diligence, perfect and adapt the same; and that, in so far as the said Bell has incorporated such improvements in his said two patents, or either of them, he (the said Bell) has surreptitiously and unjustly obtained a patent or patents for that which was in fact first invented by said Drawbaugh, who was using reasonable diligence in perfecting and adapting the same; and therefore the patent or patents of the said Bell therefor is, or are, invalid and void.

It is then said that "the defendant, relying upon his legal rights, caused application to be made and filed in the Patent Office for the invention of the said Daniel Drawbaugh, with the intention of procuring interference proceedings to be instituted in accordance with the statute, against the patents of said Bell, and the pending applications of said Gray, Edison and others, in order that said Drawbaugh might be adjudged by the Commissioner of Patents to be the original and first inventor of the electric speaking telephone, and might be adjudged entitled to receive a patent or patents therefor."

The People's Company began taking depositions on the 19th of April, 1881, but Drawbaugh himself did not appear as a witness until December 7th, 1881. After that time others were examined, and when the proofs were closed, between three and four hundred witnesses had been produced whose testimony was taken and put into the record to establish the priority of Drawbaugh's invention. This testimony, as is now claimed, shows the story of that invention to have been as follows:—

"Early conception and experiments with a continuous current, 1862 and 1866 and 1867.

"Tea cup transmitter and receiver, 1866 and 1867.

"Tumbler, tea cup and mustard can, F and D, 1867 and 1869.

"Improvement on B, namely, C, 1869 and 1870.

"Further improvements on C and the more perfect magneto-instrument I, 1870 and 1871.

"Mouth-piece changed to centre and adjusting screw inserted (exhibit A), 1874.

"D and E, perfectly adjusted and finished magneto-instruments, January and February, 1875.

"L, M, G and O, February, 1875, to August, 1876.

"H, August, 1876.

"J, N and P, 1878."

This statement of the Drawbaugh claim we have quoted from the brief of counsel appearing in his behalf, and his success in the litigation has been based, as we understand it, both in the answer and in the argument, on the truth or falsehood of what is thus set forth.

The letters F and D, &c., in the statement refer to exhibits in the case, being certain instruments claimed to have been made and used by Drawbaugh in the progress of his work, and preserved until now. The original tea cup instrument was not produced, but Drawbaugh gave in his deposition what he said was a drawing showing how it had been constructed. F, B, C, D, I and A were neither of them in a condition for use when they were put in evidence, and none of the witnesses except Drawbaugh could tell how they were originally constructed, or what the process was by which sound was transmitted when they were used. All that any of the witnesses could say on that subject was that they had used one or more of the different instruments at Drawbaugh's shop, and heard sounds and sometimes words spoken to them, and that Drawbaugh told them the sound was carried on the wire by electricity. There was nothing whatever produced in print or in writing on the subject, nor even a memorandum or drawing of any kind, and there is nothing in the testimony to show that Drawbaugh ever told any one how his earlier instruments were made, or what his process was, until he was called as a witness in December, 1881, and explained it in his testimony. This was nearly twenty years, according to the present claim, after he had begun his experiments, nearly seven years after he had made and used D and G, perfectly adjusted and finished magneto instruments, more than five years after L, M, G, O and H had been constructed and connected in his shop, if his story is true. It was also nearly six years after the date of Bell's patent, more than five years after the success of his discovery had been proclaimed at the Centennial Exhibition in Philadelphia, four years after his invention had gone into public use, three years after it had become an established success, and two years after he had brought the first suit for the establishment of his right against Dowd, who represented the Western Union Telegraph Company, to a successful termination.

(To be continued.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 31st*, 1888.

The annual meeting of the American Bell Telephone Company was held at Boston on March 27th. The statistics presented show a steady growth, nearly all the sub-companies having increased their plant and business. There are now 743 exchanges, or seven more than last year, and 444 branch offices, or two less than last year. There are 127,902 miles of wire and poles in telephone service all over the country, 9,458 miles of wire on buildings, 8,009 miles of wire underground, and 363 miles of submarine wire. The extra territorial lines now number 927, with 32,478 miles of pole line and 56,179 miles of wire. The exchanges employ a force of 6,182 people, and have 158,732 subscribers. There were in the hands of licensees 380,277 instruments, being an increase for the year of 26,759. The estimated number of exchange connections every day is 1,011,517, or the immense total for the year of 369,203,705. The daily number of calls per subscriber averages 6·37, being an increase over last year of 9 per cent., and the average cost to the subscriber ranges from 2 to 8 cents a connection, which in view of the convenience afforded is a very small outlay. The finances of the company are, it is needless to state, in excellent shape. The treasurer's statement shows gross earnings from all sources of $3,453,027, and expenses $1,242,430, leaving, with miscellaneous credits, a clear income of $2,237,608. The dividends paid during the year out of this sum amounted to $1,568,336, and there was a total surplus at the end of the year of just over $2,000,000. The report makes only a passing reference to the recent decision in the telephone case, and to the legislation attempted for regulating telephone charges. Speaking of the long-distance service, it is stated that there are now a total of 550 miles of pole lines and 10,000 miles of wire, the success, electrically as well as commercially, being beyond expectations. The income from these lines already has been more than sufficient to meet expenses, and a moderate profit is expected during the current year. The remark is made:—"The great cost of the plant is to be borne in mind in considering the direct profit from the long-line service, but the importance of the system as a safeguard to our business cannot be overestimated." The expense of completing the lines between New York and Boston, and extending from Albany towards Buffalo, as well as building the line from Chicago to Milwaukee is put at about a million dollars.

The above shows a state of affairs that must be very encouraging to the stockholders as indicating the stability of the concern and its remarkable earning capacity. At the same time, the sensitiveness of a stock that is based upon patent rights was strikingly shown last week, when upon news of the sudden death of Chief Justice Waite, of the Supreme Court, the quotations fell from 260 to 245, the reason of this being

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that the reconstitution of the court with the new judge added to it might be hurtful to the Bell interests. The argument may seem rather far-fetched, but it was sufficient to "bear" the stock.

Reference has been made above to the long-distance telephone lines as being a "safeguard to the business." It is not easy to determine just in what sense the phrase should be interpreted, but the general idea amongst electricians is that the service is not so much a defence for the American Bell Telephone Company as an offence to the Western Union Company. The lines have reached all the important points in the East, work is to be begun actively in the West, and whether it be true or not there are plenty of reports to the effect that the Western Union Company views these advances with suspicion. It is even said that the Western Union Company watches closely as to the leasing of these long-distance lines to brokers and others, and in one recent case actually made one of its customers decide outright to use either the telegraph or the telephone, the result being that the firm in question did not adopt the telephone service as it proposed. The private line service of the Western Union Company is very profitable, and hence the care with which it is protected. But it is evident that the encroachments of the telephone upon the telegraph field do not stop here, and that, as the recent blizzard exemplified, the telephone can prove a very efficient substitute for the telegraph in all work. The promptness with which the connection is effected more than offsets the higher rate of charge. This condition of affairs in America has, of course, its direct bearing on the situation in England, and the movement there for the buying out of the telephone companies by the Government is watched with interest here by many.

Mr. Jay Gould has signalised his return from Europe in a very sensational way. As you may be aware, an effort has been made to indict him and Mr. Russell Sage for alleged misappropriation of railroad moneys to the extent of about five or six million dollars. Nothing practically, has been accomplished in the matter up to the present time, nor do I think it likely that anything will be; but Mr. Gould has come out with the charge that an attempt has been made to render him the victim of a blackmailing scheme, and that the "motives" behind the criminal prosecution are "a newspaper, a cable company, and a woman." People are very much interested to know what all this pother means, and what is actually at the bottom of Mr. Gould's accusations. The Commercial Cable Company says that it practically knows nothing about the indictment hanging over Mr. Gould, whose assertion is intended really, it thinks, to have an influence in England. The *Herald* may, of course, justify its attacks on Mr. Gould upon the ground of public policy, but how all the various anti-Gould elements are allied and mixed up in this matter nobody seems to know.

The bids for city lighting in New York for next year have just been filed, and it is cheering to note that as far as electric lighting is concerned they all strike a much higher average than they did last year, when cut-rate competition prevailed, and prices were reduced far below their proper level. The companies this year tender at from 32 to 59 cents per arc lamp per night, and the average of the bids seems to lie around 40 cents, which is generally regarded here as a fair price. No contracts have yet been awarded, but it is safe to expect that when made they will be on a better basis. When the bids were presented the mayor made an inquiry as to why one of the companies had failed to furnish lights under its contract, and was informed that the Board of Electrical Control had refused the company the privilege of putting up the necessary poles and wires; under these circumstances it was obvious that the company could not very well carry out its contract. This year, however, the deadlock will probably be broken. A good deal of opposition to the Subway Board is still shown in this city, and it found expression last week when the Postal Telegraph and Cable Company, and one or two others under practically the same management, obtained an injunction preventing the Board from selling them out, because they would not pay the amount assessed on them to meet the expenses of the Board. The taxation referred to is opposed on various grounds, the chief of which are that the expenses of the commission are far too high, and that the assessments are levied without being fairly divided up amongst the companies liable.

Dr. Norvin Green made an interesting statement this week before the United States Senate Committee on Inter-State Commerce, which now has in hand the Spooner Inter-State Telegraph Bill, of which I have already sent you some particulars. He mentioned the fact that the Western Union Company has contracts with 600 railroads for which free and half-price service was rendered in return for transportation, and suggested various amendments in the provisions proposed by the Bill to meet the conditions of the case in that respect as well as in others. He was desirous of seeing a clause to settle the liability of the company to produce telegrams under subpœnas from courts, &c., and was also wishful of having a limit set to the amount of damages that could be collected for the delay in the transmission of messages. Col. Robt. Ingersoll appeared before the committee on behalf of the Postal Company, and I judge from the tenor of the inquiry and the drift of things, that the agitation for Government telegraphs may simmer down this year into the adoption of the Inter-State Bill.

The effect of the Bell telephone decision has been to encourage the makers and vendors of acoustic telephones to new efforts, and to direct attention again to systems of telautography. Prof. Elisha Gray, for instance, is putting forward a telautograph which is to make amends to him for the telephone, out of which he considers himself to have been defrauded. He says that with this apparatus, which will not cost more than $15 or $20, and is easily kept in order, full written communication can be had through the usual switchboard arrangements, between any number of persons, as in a telephone exchange system. I hear that capitalists are looking into the matter, and that early practical developments may be expected. As you are aware, a device of this kind, known as the "writing telegraph," has been exploited here recently, and was introduced in Rochester, Pittsburg, and one or two other places, but I cannot ascertain anything that would establish it as a present great success. Evidently the thing is worth striving after, and the complete invention, giving easy means of conversation and record, would be very valuable, in America at any rate.

Strenuous attempts are still being made here by the Stock Exchange and legislators to crush out the "bucket shops," where gambling in fractional stocks is indulged in; but, like the telegraph schools, the bucket shops live on. The evil has lately made itself felt in Canada, and a Bill has been introduced this week in the Dominion Senate at Ottawa of a very severe character, proposing to inflict on anyone who may be engaged in bucket-shop transactions a fine of £1,000, or five years' imprisonment, and on frequenters of the places imprisonment of at least a year.

NOTES FROM STOCKHOLM.

(FROM OUR OWN CORRESPONDENT.)

The Malmö Electric Light Company, Malmö, Sweden, held its first annual meeting on Tuesday, April 3. The directors stated that the cost of erection amounted to 44,730kr., or about £2,500. There were two steam engines, each of 42 horse-power, and three dynamos, two with a capacity of 435 lamps, and one with a capacity of 140 lamps. As the installation had not been completed at the time originally intended (last autumn) only two arc lamps and 704 incandescent lamps had hitherto been taken in use, though additional subscribers for some 200 lamps were confidently reckoned upon within some little time.

The Electric Company (Limited), Stockholm (Elektriske Aktiebalaget, Stockholm) held its annual meeting in the Stockholm Exchange, on Wednesday, April 4th. The report states that the business of the company increases for every year. During the year 1887 the company's new installations comprised over 2,650 incan-

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descent lamps, against a total of 5,300 incandescent lamps during the previous four years. The power at the works of the company at Arbaga is transmitted by dynamos, which is the only instance of the kind in Sweden. This arrangement has been in force for rather more than a year, and has given entire satisfaction. Last year's profits amounted to 10,036kr., which it was decided to add to the capital of the company. Mr. Ludvig Fredholm was re-elected as managing director, and Prof. J. E. Cederblain and Mr. Auz. Mueller as co-directors.

The Swedish Diet is experiencing some difficulty in arriving at a result with regard to the proposed telephone tax, one Chamber having voted in favour of it and the other against it. The matter will now be settled by a joint voting of both Chambers.

The Bell Telephone Company, of Gothenburg, passed on the 1st of April into the possession of the State Telegraphs, both as regards stations and wires within Gothenburg and the connections with places outside the town. Mr. V. Brusevitz will continue to manage the telephone station.

The Swedish Government has issued an order that all the pupils at the mine section of the military school at Karlskrona shall be instructed in practically tending electric lamps, both arc and incandescent. The necessary appliances and funds have been placed at the school's disposal.

CORRESPONDENCE.

SMALL DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have a small dynamo of the Gramme type, having 12 teeth in the armature, wound on the field-magnets with 6lb. No. 22 S.W.G. (R = about 30 ohms), and on the ring 7oz. No. 20 S.W.G. (R = about ·87 ohm). I can by no means obtain a current from this machine worth speaking of at 1,300 revolutions. Would someone more proficient than myself kindly point out the probable source of my error, and say if I ought to alter size or length of wire, speed, &c., and when altered and set up as it should be, the number of 10 candle-power lamps this machine *ought* to light? Hoping that my wants, which I know are many, have not led me to ask too much.—Yours, &c.

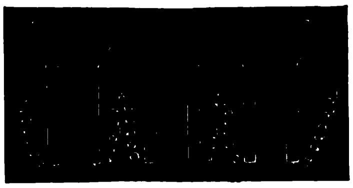
ONE OF THE UNPROFESSIONAL READERS.

[It is not possible to give a definite answer to our correspondent's inquiry from the meagre information contained in his letter. The machine is evidently intended to have the field coils connected in shunt with the armature—possibly he has joined them up in series. Other things being equal, the *current* obtainable depends solely on the heating of the armature, but this depends on several things besides size of wire. Probably about three amperes, or say three or four 10 candle-power lamps at 50 volts, would in this case be the maximum safe load. Whether the machine may be expected to give 50 volts at 1,300 revolutions it is impossible to say without further information. If, however, our correspondent cares to send us drawings, with detailed dimensions, we shall be pleased to go further into the question, and to communicate with him by letter.—ED. *E.*]

CONSTRUCTION OF RESISTANCE COIL BOXES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In one of your recent issues under the head of "Letters for Learners and Un-Professional Readers" the instructions are given for the construction of resistance sets in which the coils are represented as being connected to a rod or post attached to the block on the cover of the instrument, there being only one post to each block, and the two terminals of the two adjacent coils attached to this. I want to call attention to the error introduced by constructing boxes in this way, especially because I myself once had a box, made by makers of great reputation in the manufacture of electrical apparatus, in which the coils were so connected, and it led me into considerable trouble before I found it out. The difficulty is this, that when any one of the coils is used alone, the two posts enter as a part of its resistance, but when successive coils are used in series, only the first and last post enter into the resistance of the series, and the coils, therefore, do not sum up exactly, as they measure separately. The error, of course, is of little consequence except in the case of coils whose resistance is small, but in the case of ohms the error is quite appreciable, and even in 10-ohm coils the difference can be detected when measurements are made with extreme accuracy, and in case of 10-ohm coils the difference is a very considerable percentage of the whole.



The proper method of construction is to connect two posts with each block, and then connect the terminals of one coil to one post and of the other coil to the other, as shown in the accompanying sketch; and in the construction of resistance boxes for very accurate work the writer has made the posts for all the coils up to and including 10 ohms of German silver, in order that errors due to a variable temperature coefficient might not enter to change the values.—Yours, &c.,

April 2nd, 1888. WM. A. ANTHONY.

THE SALE OF TELEPHONES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Swinton's letter in your last issue clearly refers to our advertisement, and, being very misleading, calls for a reply.

The armature used by Mr. Swinton in his receivers consists of an iron strip, fixed at each end to the two metal rings, between which the diaphragm is held. If the diaphragm be entirely removed, the armature will remain self-supporting. We understand it is on this point that the United Company attack Mr. Swinton's receivers.

It would be inferred from Mr. Swinton's letter that our receivers are similar to his own, but they are not. Mr. Moulton, Q.C., who has fought on the United Company's side in all or most of their battles, has given his decided opinion that the Stanhope telephone does *not* infringe Bell's patent, and his opinion is supported by other eminent counsel.

We fail to see Mr. Swinton's motive in writing the letter referred to, which would more naturally have come from the plaintiff company had there been any ground for it.—Yours, &c., JOHN S. SAWREY, Managing Director.

The Stanhope Company (Limited), April 10, 1888.

ON A GLASS CONDENSER.*

BY J. LEHMANN.

The author had noticed that a Leyden jar apparently required fewer turns of a frictional machine to charge it to a given potential after it had been standing idle for some time than when it had been frequently charged and discharged. He thereupon constructed a condenser of glass plates about 1 square inch surface and ·0008 inch (·02mm.) thick. These he coated on *both* sides with silver, and thus ensured that the metal was everywhere in intimate contact with the glass, thus avoiding a possible error due to air acting partially as the dielectric. The silver was removed round the edges of the plates with nitric acid and connections made by strips of tin foil. Three such plates were used and found to have a capacity of 0·023 micros. at 20deg. C.

The standard condenser with which this was compared was (apparently) a paper one, and had a capacity of 0·3 microfarad. The charging battery was 5 Daniell cells. The scale readings were proportional to a fraction of one division for from 1 to 10 Daniells. The following table shows the behaviour of the two condensers (after being earthed for 24 hours beforehand).

* Abstracted from the *Centralblatt für Elect. Tech.*

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The mark * means that the charge was as instantaneous as possible, the discharge following immediately.

TABLE I.

Standard Condenser.		Glass Condenser.	
Length of Charge.	Throw.	Length of Charge.	Throw.
*	652	*	44
30 sec.	655	10 sec.	52
*	652	*	44
1 min.	656	1 min.	50
*	656	*	49·5
*	655	*	48
	etc.		etc.
*	652	*	44
2 min.	656	2 min.	50
*	655	*	49
	etc.		etc.
*	652	*	44
Maximum increase = 4 in 652 = 0·61%		Maximum increase 8 in 44 = 18·2%	

The author considers the results may be equally well explained on the theory of permeation of charge, or on Kohlrausch's theory of polarised molecules.

The glass condenser was then charged for varying times, discharged, insulated for ten seconds, and then the throw due to residual charge was taken.

TABLE II.

Time of Charge.	Throw of Residual.
*	4
1	5·5
2	6
4	10
6	11
8	12
10	12·8
15	13
30	14

There was considerable loss of charge due to conduction through the glass. The author goes into considerable detail on this point; suffice it to say that he found this loss at −3deg. to be from ⅓ to ½ that at +20deg.

A long series of tests then shows the relation between temperature and capacity, which we can only give in brief. For the higher temperatures one plate was used; for the lower set, three.

Temperature.	Discharge Throw.	Temperature.	Discharge Throw.
+20	16	+20	50
30	22	0	40·5
40	30	−10	35
50	46	−25	33·2
60	91	−35	32·9
70	178		
80	265		
90	394		
100	722		

The following table is curious, showing that at low temperature the residual appears to vanish:—

Temperature.		95°	50°	20°	0°	−10°
Charged for 10sec.;	throw =	425	40	15·3	12·5	11·5
„ 5sec.	„	335	38	15	12·4	11·5
„ *	„	195	36	13·8	12·2	11·5

Strong heating or cooling appears, says the author, to have an effect on the dielectric qualities of the glass which lasts for a considerable time. To this point he hopes to return in a future paper.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

4,844. W. P. THOMPSON. Liverpool. Improvements in or relating to holders for incandescent electric lamps by which they are made applicable as combined holders and circuit closers and breakers (N. E. Garczynski). March 31, 1888.

4,875. A. WILSON and J. F. SAFE. London. Improvements in machinery for raising and lowering submarine telegraph or other cables. March 31, 1888.

4,909. J. C. FELL. London. An improved telephonic apparatus (P. C. C. Otzen, Denmark). March 31, 1888.

4,929. W. GILLETT and G. HASELTINE. London. Improvements in magneto-electric generators. April 3, 1888.

4,940. T. PARKER. Manchester. Improvements in and relating to alternating-current dynamo electric machines. April 3, 1888.

4,964. A. J. BOULT. London. Improvements in apparatus for the changing and regulating of electric currents (S. Doubrava, Austria). April 3, 1888.

5,029. A. H. MOBSBY and A. F. DAVIES. London. Generation of electricity by tidal or river power. April 4, 1888.

5,069. C. A. RANDALL. London. A combined mechanical and electromagnetic motor. April 5, 1888.

5,082. R. P. SELLON and R. C. JACKSON. London. Electricity meters. April 5, 1888.

5,098. P. L. KRICBOOM. London. Method of and apparatus for electrical signalling or announcing in connection with telephone circuits. April 5, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

April 7, 1888.

6,104. A. LE NEVE FOSTER and F. V. ANDERSEN, London. Improvements in electrical measuring instruments. April 26, 1887.

6,219. J. SWINBURNE, Chelmsford. Improvements in or connected with induction apparatus and the use of it in studying dynamo electric machines. April 26, 1887.

7,184. W. MACKIE, London. Improvements in electric arc lamps. May 17, 1887.

7,982. C. L. W. FITZGERALD, London. Improvements in or additions to telephonic instruments for enabling them to be used only on prepayment for such use. June 2, 1887.

7,950. D. J. SMITH and H. F. JACKSON, London. Improvements in or connected with telephones for indicating and recording the number of times that a telephonic instrument is used for ascertaining payments due or for other purposes. June 1, 1887.

8,159. W. SMITH, London. Improvements in effecting electric telegraphic communication applicable especially for telegraphing to lighthouses, either floating or on rocks, at a distance from the shore or for telegraphing to or from vessels. June 7, 1887.

2,179. M. WHEELER, London. Improvements in incandescent electric lamps. February 13, 1888.

2,246 H. H. LAKE, London. Improvements relating to dynamo electric machines (R. Eickemeyer, United States). February 14, 1888.

2,250. J. H. LINVILLE, London. Improvements in printing telegraphs. February 14, 1888.

2,308. C. COERPER, London. Improvements relating to dynamo electric machines. February 15, 1888.

PATENTS SEALED.

April 6, 1888.

747. F. WYNNE. London. Means or apparatus to be employed in the application of electricity to propel vehicles on roads with or without tram or other rails. January 17, 1887.

949. G. PERCIVAL. Cork (City). An electrical switch or circuit-closing and interrupting device of improved construction. January 21, 1887.

2,419. F. BOSSHART. Manchester. Improvements in dynamo-electric machines (A. L. Hillaire Desbois, France). February 16, 1887.

4,546. C. D. ABEL. London. Improvements in dynamo electrical machines in combination with motor engines (Siemens and Halske, Germany). March 26, 1887.

4,553. W. DICKENSON. Newfoundland. Improvements in electric telegraph apparatus. March 26, 1887.

4,914. R. D. SMILLIE. West Brigend. Improvements in switches for making and breaking electric circuits. April 2, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

4,545, 1887. C. D. ABEL (Siemens and Halske). Electrical measuring and indicating apparatus. (Price 8d.)

4,714, 1887. F. A. AMORIC. Electrical signal bell apparatus for single-wire circuit. (Price 8d.)

5,186, 1887. A. P. TROTTER and W. T. GOOLDEN. Dynamo electric machines. (Price 8d.)

5,210, 1887. A. SERRAILLIER. Automatic apparatus for subjecting the person to electric currents. (Price 8d.)

6,409, 1887. R. E. B. CROMPTON and W. A. KYLE. Dynamo electric machines. (Price 8d.)

6,681, 1887. R. E. B. CROMPTON and J. C. HOWELL. Secondary batteries. (Price 8d.)

7,317, 1887. J. KYNOCH and W. HABGOOD. Secondary electric batteries. (Price 4d.)

8,262, 1887. W. M. MORDEY. Electric generators. (Price 11d.)

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LEGAL INTELLIGENCE.

Avery v. National Company for the Distribution of Electricity by Secondary Generators (Limited).

This was an action to recover £250, money lent, and for an order compelling the defendant company to register the plaintiff as a holder of 200 Preference and 100 Ordinary shares, and also for an account of dividends and profits due.

Mr. Cripps and Mr. Ellis appeared for the plaintiff; Mr. Muir Mackenzie for the defendants.

The facts of the case were as follows:—The plaintiff is the administrator with the will annexed, and also a creditor of the late George Michael Maurice Yvers Le Fez, a Frenchman resident in London, who was a director of the defendant company, and at the time of his death credited in the books of the company with the sum of £250, money lent to the company, and also appeared on the register as the holder of 200 Preference shares and 100 Ordinary shares. Le Fez was acquainted with the Count and Countess de Rocquigny, who were then residing in London, and was their debtor. On October 15th, 1884, Le Fez wrote a letter to the directors of the defendant company resigning his directorship and authorising them to transfer the whole of the shares standing in his name into the name of the Countess de Rocquigny, and also assigning the debt for £250 to her. Le Fez committed suicide on October 17, leaving a will dated October 16, 1884, which was made according to French law and proved in Paris. After the death of Le Fez the above letter of October 15 was found in his room, and was taken to the directors on October 23 by Mr. V. Williams, who was then acting as solicitor for the countess. The directors refused at first to make the transfer, and the shares and debt were not transferred into the name of the Countess until February, 1885. The case now set up on behalf of the plaintiff was that the letter of October 15 was not a legal transfer of the shares, and was never delivered by Le Fez to the company, and that the transfer so improperly made should be set aside.

Mr. Justice MATHEW having summed up, the jury almost immediately returned a verdict for the defendants.

COMPANIES' MEETINGS & REPORTS.

The Telephone Company of Ireland (Limited).

The ninth ordinary general meeting of the proprietors of this Company was held at the offices of the Company, Commercial-buildings, Dean-street, Dublin, on Monday last.

Mr. V. B. DILLON, solicitor to the Company, was in attendance.

Mr. JOSEPH BOND MORGAN, in moving that the High Sheriff, Alderman Winstanley, should take the chair, said they regretted exceedingly that they had not amongst them their late chairman, Mr. Edmund Dwyer Gray. The Telephone Company would miss him immensely, for he was a great power not only in that Company but also in respect of the assistance which as a member of Parliament he rendered to telephone interests generally. He took a very active part in a special committee ordered by Parliament to consider the position of the telephone companies in relation to a Bill in which they sought to obtain the power of way-leaves. His action in the matter had been of great service to telephone interests, and the matter was now being pressed with great vigour, and they trusted that material benefits would result to the companies.

Mr. HERMANN G. ERICHSEN, in seconding the motion, said he would only repeat what had been said in the public prints of Mr. Gray—namely, that he was a most honest, honourable, amiable, and, he would add, able man.

Alderman WINSTANLEY, having taken the chair, moved the adoption of the report, which has been already published, and the accounts. He could not do so without alluding to the great loss which that and other telephone companies had sustained by the death of their late lamented Chairman. He was a man the like of whom they seldom met. Not only was he an excellent man of business, but he was a man well known throughout the entire of the United Kingdom. In his business capacity, as a literary man, and as an orator, he adorned everything that he touched, and brought to whatever he undertook an amount of intelligence, perseverance, and industry that guaranteed success. They had always found him an excellent member of the Board of that Company, for whenever they found themselves in a difficulty they had only to refer to him in order to be assisted through, and enabled to carry whatever they had in hand to a successful issue. Much had been said of him in the public press of England, Ireland, and Scotland, but not a word more than he deserved. With regard to the report, the figures which it contained spoke for themselves, and showed that the Company had been fairly successful during the year. They obtained 73 new subscribers during the year, but lost 52 by deaths and other causes, which left a net increase of 21. During the first couple of years they did not write off any bad debts; in fact, they thought their business would not lead to any, but they found it impossible to avoid them. From deaths, failures, and one cause or another they made something over £100 a year of bad debts, and these accumulated to £323. 7s. 6d.; but in the year 1887 they had not only written off the whole of that amount, so as to be able to start fair in 1888, but they had also been able to put 10 per cent. of their earnings to their reserve fund and to carry a considerable sum forward. They had also made such arrangements as would, he believed, enable them to avoid bad debts in future, or at all events to incur very few. Arrears were no longer allowed to accumulate in the Post Office royalty, which was payable in advance. Their business was now on a sounder basis than it had been in any previous year, and all doubtful proposals were declined, except on such terms as would ensure the Company against loss. It was a matter of congratulation to the shareholders that the gross revenue of the Dublin exchange for the past year had been upwards of £10,000. In the year 1884 it was under £5,000, so that in three years it had increased at the rate of 400 per cent. That was a satisfactory and remarkable development, and it would be more pronounced but for the obstruction which they still received from the Postal Telegraph Department. The Directors would have long since established call offices at all the suburban railway stations and at the suburban post offices where no telegraph existed, but for the refusal of the Post Office to give their consent—a policy which he considered wholly inexplicable. It was to be hoped, however, that the Postmaster-General would soon give them a fair field, and that the heavy tax of 10 per cent. on their gross revenue would be removed, and every possible facility given for their operations, for it was a scandal that what had become a necessity for all business pursuits should be subject to the existing tax upon it. It was also very hard that the Government should arbitrarily refuse the Company leave to have call offices at the railway stations merely because the former claimed exclusive rights for telegraphic purposes. In addition, if the Telephone Company wanted to cross a railway or to go along its banks they were charged an extra tax besides the 10 per cent. royalty on their gross income in consequence of this claim of the Government to the exclusive use of the railways for telegraphic purposes. In this connection the Company would greatly miss the energy and ability of their late Chairman, who was deeply interested in the removal of the obstructions placed in the way of the development of the telephone system, in which he took an absorbing interest, and who had done great service not only to that Company, but to the telephone world in general by his action in Parliament and the interviews which he had with the Postmaster-General on various occasions.

Mr. ERICHSEN seconded the motion, which was unanimously agreed to.

The CHAIRMAN moved a resolution striking a dividend at the rate of 1 per cent. per annum on the ordinary share capital of the Company, and confirming an ad interim dividend of ½ per cent. per annum struck last August.

Mr. ERICHSEN seconded the motion, which passed unanimously.

On the motion of Mr. MORGAN, seconded by Mr. DUDGEON, the retiring directors, Mr. Erichsen and Alderman Winstanley, were re-elected.

On the motion of Mr. HOPKINS, seconded by Mr. JAMES M'GOLDRICK, the retiring auditor, Mr. John M'Kean, was re-elected, and the remuneration of the two auditors was fixed at 50 guineas for the year for both.

The proceedings then terminated.

Oriental Telephone Company (Limited).

Report of the Directors for the year ended 31st December, 1887, to be presented at the eighth ordinary general meeting of the Company, to be held at the City Terminus Hotel, Cannon-street, E.C., on Wednesday, the 25th inst., at 1 o'clock.

The revenue account for the year exhibits a balance to credit of £5,854. 15s. 10d., which has been transferred to the profit and loss account. To this amount has to be added the sum of £4,769. 11s. 3d. brought forward from last year, making a total sum to credit of profit and loss of £10,624. 7s. 1d. In accordance with previous balance-sheets the Indian guarantees for the year, viz., £2,406. 18s. 11d., have been debited to this account.

The Directors have deemed it advisable to reduce the item of preliminary expenses, and have consequently written off a sum of £1,128 in respect of these. They have further written off £259. 7s. 10d. for depreciation of stores at the various branches, and £121. 3s. 3d. in final settlement of losses on shipments of instruments to Australia on joint account, dating from 1882, with the Consolidated Telephone Construction and Maintenance Company (Limited).

The nett balance, therefore, to credit of profit and loss, after deducting the above items, is £6,708. 17s. 1d.

The Directors recommend a dividend for the past year of 2½ per cent., free of income-tax, on the paid-up capital of the Company other than the vendor's shares. This dividend will absorb £3,106. 1s., and leave £3,602. 16s. 1d. to be carried forward.

The Telephone Company of Egypt continues to make satisfactory progress, and the dividend of 6 per cent. declared by that company for the past year on its preferred capital has been brought into the present accounts.

The revenues of the Indian subsidiary companies are maintained. The Deferred shares held by this Company will this year rank for dividend as well as the Preferred shares.

The China and Japan Company has, as was anticipated in last year's report, been able to finally extinguish the deficit arising on previous years' workings, pay its debenture interest and carry a small sum forward.

The exchanges worked by the Company all show a profit for the year. In order to give the most efficient service at Rangoon, the Magneto system is now being introduced. This completes the change of system throughout the Indian exchanges.

The retiring directors are the Right Honourable G. A. F. Cavendish-Bentinck, M.P., and B. St. John Ackers, Esq., both of whom are eligible and offer themselves for re-election.

Messrs. Deloitte, Dever, Griffiths and Co., the auditors of the Company, retire and also offer themselves for re-election.

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Montevidean and Brazilian Telegraph Company (Limited).

Directors' report to be submitted at the ordinary general meeting to be held at the Company's offices, 2, Tokenhouse-buildings, London, E.C., on Monday, the 16th inst., at one o'clock:—

The percentage of gross revenue receivable from the Western and Brazilian Company shows a slight increase, being £2,508. 9s. 1d., as compared with £2,370. 6s. 5d. in 1886.

The Directors had hoped from the improved condition of trade with South America that they would have been able to report a more favourable result to the shareholders.

The Directors are glad to observe that, so far as can be judged from the published returns of the Western and Brazilian Telegraph Company, there appears some prospect of a greater improvement in the traffic during the current year.

The shareholders will remember that the debentures issued in 1876 were made redeemable on the 1st of July, 1896. There being a balance of £10,280 still unredeemed, it will be necessary to set aside annually a larger sum for the purpose of redemption than hitherto, and the Directors therefore propose to appropriate £1,000 for that purpose for the year 1887, which leaves a balance of £474. 7s. 11d. available for division.

The Directors recommend the payment of a dividend at the rate of 1s. per share on the Preference shares of the Company, which will absorb £415. 14s. 0d., leaving a balance of £58. 13s. 11d. to be carried forward to next account.

The Directors regret to inform the shareholders that Sir Thomas Gore Browne, K.C.M.G., C.B., who so long occupied the position of Chairman of the Company, died in the month of April, 1887.

Mr. James Joicey, M.P. (whose interest in the Company as a shareholder is larger than that of any other gentleman), was appointed a Director of the Company, to fill the vacancy left by the death of Sir Thomas Gore Browne.

The retiring Director is Dr. Charles Cameron, M.P., who being eligible offers himself for re-election.

The auditor, Mr. W. S. Ogle, chartered accountant, also retires, and offers himself for re-election.

NEW COMPANIES REGISTERED.

TUNBRIDGE WELLS ELECTRIC LIGHT COMPANY (LIMITED).—This company was registered on the 29th ult., with a capital of £30,000, in £5 shares, to carry on, at Tunbridge Wells, the business of an electric light company, in all branches, and also the business of a telephone company. The subscribers are:—

	Shares.
H. T. Chetwynd Stapylton, J.P., 72, Warwick-square	10
W. H. Hodkin, Tunbridge Wells, banker	1
G. Chaverton, Tunbridge Wells, chemist	1
E. Durant, Tunbridge Wells, grocer	1
E. Waymark, Tunbridge Wells, draper	1
B. C. Colls, Tunbridge Wells, tailor	1
E. A. Hallingham, Tunbridge Wells, veterinary surgeon	1

The number of directors is not to be less than 3, nor more than 7; the subscribers are to appoint the first, and are to act *ad interim*; qualification £50 in shares or stock; the remuneration of the board will be £50 per annum, and such further sum as may be determined by the company in general meeting.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY (LIMITED).—This is a reconstruction of the Kensington Court Electric Lighting Company (Limited), upon the basis of an agreement of the 23rd ult., between Granville Richard Ryder and Douglas Eyre. It was registered on the 29th ult., with a capital of £250,000, in £5 shares. The subscribers are:—

	Shares.
E. W. Cox, 1, Gayton-crescent, Hampstead	1
W. Eacott, 9, Gore-road, South Hackney	1
Samuel Jordan, 36, Gertrude-street, Fulham-road	1
H. Gibson, 4, St. Mary-axe, solicitor	1
E. W. Loyd, Lancaster-road, Upper Norwood	1
G. Hamlin, 43, Somerleyton-road, S.W.	1
B. W. B. Ulph, 1, Findon-road, Uxbridge-road	1

The number of directors is not to be less than three nor more than nine; the first are G. R. Ryder, A. Sohier Bolton, Sir Charles Grant, and Roger William Wallace; qualification, £100 in shares; the company in general meeting will determine remuneration.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended April 6th, 1888, amounted to £4,503.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of March was 4,919, estimated to produce £3,800, against 4,775 messages, producing £3,727 in the corresponding month of last year. The traffic receipts for the month of December, estimated at £3,300, realised £3,373.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—This company announce the numbers of 276 Five per Cent. Australian Government Subsidy Debentures, which have been drawn for payment on 1st July next, full particulars of which will be found in our advertising columns. The traffic receipts of this company for the month of March, 1888, amounted to £39,670, and to £38,177 in the corresponding period of 1887, showing an increase of £1,493.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of March, 1888, amounted to £54,376, and to £49,797 in the corresponding period of 1887.

GREAT NORTHERN TELEGRAPH COMPANY.—This company announces the opening of new stations in China on the Island of Formosa at Taiwan, Takow, and Anping. The rate from all places in the United Kingdom is 8s. 9d. per word. The latest traffic returns of this company are as follows:—Receipts in March, 1888, £22,000; from January 1st to March 31st, 1888, £63,800; corresponding months, 1887 and 1886, £61,200 and £58,680 respectively.

INDO EUROPEAN TELEGRAPH COMPANY.—The directors, after adding £10,000 to the reserve fund, recommend a dividend for the six months ended the 31st December, 1887, of 17s. 6d. per share, making with the interim dividend already paid 6 per cent. for the year and a bonus of 20s. per share, making in all 10 per cent. for the year, carrying over £2,694. A year ago the distribution was the same and £1,093 was carried forward.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The directors of this company, after placing £15,000 to the renewal fund, and £10,000 to the debenture redemption fund, have decided to recommend at the forthcoming meeting of the company that a dividend of 9s. per share (free of income-tax) be paid. This, with the interim dividend already paid in October last, makes a total distribution for the past year of 4½ per cent. per annum, as compared with 3½ for the year 1886. The traffic receipts of this company for the week ended April 6th, 1888, after deducting the "fifth" of the gross receipts payable to the London-Platino-Brazilian Telegraph Company (Limited), were £3,554.

REMOVAL.—We are informed that Messrs. W. F. Dennis and Co. have removed from Leadenhall House, 101, Leadenhall-street, London, to 11, Billiter-street, London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, April 11, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending April 11, 1888. Highest.	Lowest.
£			**TELEGRAPHS.**		£. s. d.			
1,770,360	Stock	10/0	Anglo-American	39 40	3 10 6	Jan., Apr., July, Oct.	39¼	...
2,614,820	Stock	20/0	Do. Preferred	65 66	4 5 3	,, ,,	66¾	65½
2,614,820	Stock	nil.	Do. Deferred	13½ 14½	...	February	...	...
130,000	£10	3/0	Brazilian Submarine	12⅛ 12⅜	5 14 6	Mar., June, Oct., Dec.	12⅜	12⅛
16,000	10	8/0	Cuba Submarine	12½ 13	6 3 2	February and August	13	...
6,000	10	10/0	Do. Preference	18½ 19½	5 2 6	,, ,,	...	...
12,931	5	2½%	Direct Spanish (£4 paid)	3¾ 4¼	3 10 0	March & September	...	...
6,000	5	5/0	Do. Preference	8½ 9½	5 5 3	April and October ...	9⅜	8⅞
60,710	20	2/0	Direct United States	8⅝ 8⅞	4 11 6	Jan., Apr., July, Oct.	8⅞	8⅝
380,000	10	2/6	Eastern	11¾ 12	4 11 8	,, ,,	11⅞	11 11/16
70,000	10	3/0	Do. 6 per Cent. Preference	15 15½	3 18 0	,, ,,	15½	15¼
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	108½	...
250,000	10	5/6	Eastern Extension	12¾ 13	4 14 3	Jan., Apr., July, Oct.	12⅞	12 5/16
22,050	10	5/9	German Union Telegraph and Trust	9 9½	6 3 3	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅞ 6⅛	4 12 0	Jan., Apr., July, Oct.	6⅛	5 15/16
178,992	10	3/0	Do. 6 per Cent Preference	13⅞ 14⅛	4 5 8	,, ,,	14⅛	13⅞
150,000	10	5/0	Great Northern	14¼ 14¾	5 5 6	Jan., July, and April	14¾	14½
17,000	25	5%	Indo-European	38 40	6 5 0	April and October ...	40	...
38,348	10	3%	London Platino Brazilian	5¼ 5¾	5 4 4	May and November	5¾	5½
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October ...	...	...
338,225	Stock	15½%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	5¼ 5¾	8 13 9	January and July ...	...	...
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88,321	10	nil.	West India and Panama	½ 1	...	...	...	...
34,563	10	9/0	Do. 1st Preference	10¼ 10¾	6 19 6	April and October ...	10⅝	10½
45,181	15	3/9	Western Brazilian	10 10½	7 1 6	March & September	10 5/16	9 15/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅝ ¾	5 9 0	Yearly	...	...
220,000	£1	...	Oriental (11s. paid)	5/16 7/16	...	...	⅜	...
80,000	5	5/0	United	14¾ 15¼	4 11 3	June and December	15 7/16	14⅞
50,000	5	2/6	United River Plate	4¾ 5¼	...	April and October ...	5⅛	5
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb. '86	Anglo-American Brush (£4 paid)	2¾ 3¼	...	...	...	...
23,692	5	2/0 ,,	Do. (fully paid)	3½ 4	...	February & August	3⅞	3¾
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2½	...	...	2½	2 5/16
312,000	¼	5% '86	Maxim-Weston	1/16 3/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	6 1 3	March and July	39¾	39
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 0	February & August	17½	16¼

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ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

The action brought by the Edison-Swan Company against the makers of the "Victoria" lamp is based upon the same two patents as formed the subject of a suit brought by the present plaintiffs against Messrs. Woodhouse and Rawson two years ago, and also since that time against Shippey Brothers. The two patents in question are :—(1) of Edison, No. 4,576, of November, 1879; and (2) of Cheesborough (the agent for Sawyer-Man in this country), No. 4,847, of November, 1878. The defendants in this action, though nominally William Holland and the Jablochkoff Company, are actually the Anglo-American Brush Corporation. The names of the former merely appear as clients and users of the Brush Company's Victoria incandescent lamps, selected for the purpose of a test-action to determine the right of the Edison-Swan Company to restrain all users of the incandescent lamps in this country (upon the strength of the judgments already delivered in favour of the Edison-Swan Company) from using any other than lamps manufactured by the latter company.

It will no doubt be remembered that in the Woodhouse and Rawson case judgment was given for the plaintiffs for both patents by Mr. Justice Butt; on appeal, the decision of Mr. Justice Butt was upheld on both patents, the three judges being unanimous in the view taken of the Cheesborough Patent; Lord Justice Cotton, however, putting a different construction to that of his brother Lords Justices, Bowen and Fry, in respect of the Edison Patent. As regards the latter, the whole issue resolves itself into the use, by Edison, of the term and claim for "filament." Singularly enough, this is the first occasion on record of the word "filament" being used to denote the illuminating portion of an incandescent lamp, and this fact affords a subtle but none the less powerful weapon when ably handled by brilliant counsel and skilful scientific experts. Edison, after describing various processes of manufacture of what are indifferently referred to in the body of the specification as "wires," "sheets," "strips," and "filaments," concludes by making four claims. The last two are claims of detail, and are of no importance for the purposes of the present action, so that the fight virtually centres round the first two, and more particularly the *second* claim, which is for the "combination of a carbon filament within a receiver entirely of glass, through which the leading wires pass, and from which the air is exhausted." The point upon which the Court of Appeal in the Woodhouse and Rawson action differed, was as to whether this claim should be construed to signify "a carbon filament" however made, or "a carbon filament" made as described in the body of the specification. The majority of the Court, however, put the former construction upon the claim, and it is this construction which in a great measure is being argued in the action now proceeding. The expression "filament" is a kind of *lusus naturæ*, to define and set bounds to which has taxed the ingenuity of the four judges who have up to the present endeavoured to cope with it. At one moment it is something which is "resilient," and "elastic," and "flexible;" at another something wherein the ratio of length to diameter is something considerable; at one time it is to possess the essential feature of "high resistance;" at another it is that which is "formed into filamentous form before carbonisation;" and finally it is "that which has succeeded where previous attempts have failed." In the present action all these characteristics and a great many more are being exhaustively discussed, and if the accumulated talent of the Bar, and of the the electrical, chemical, and physical worlds can assign boundary lines to this hitherto indefinable quantity, some such result may be looked for as the outcome of the present action.

As regards the Cheesborough Patent the position is less complicated. The patent is one for the process known as "flashing" among incandescent lamp manufacturers, and is alleged to cover the process of electrically heating in hydrocarbon gas to produce uniformity of resistance and candle-power among incandescent lamps. In this case the issue is not of primary importance, for under the improved knowledge existing at the present day as to various processes in manufacture, "flashing," though a convenience and largely resorted to, is not indispensable.

The surveyor of the Chelsea Vestry considers himself entitled to be highly amused because ten different electric lighting companies have given him ten different estimates avowedly based upon as many different constructions of his "specification" for the lighting of the Chelsea Vestry Hall. But since the "specification" specified nothing whatever except the number of lamps required we do not think that the surveyor is legitimately entitled to indulge in sarcastic observations at a result which was simply inevitable. An expenditure of only a small part of the trouble which he has since taken in "standardising" the estimates would have enabled him to draw up a general statement as to what was and what

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was not expected to be included in the tender. Such a general statement need not necessarily be of a technical character, but it would, doubtless, have saved much time and trouble in preparing the estimates. On the other hand, the surveyor would probably have found the results not only less funny, but less instructive also. Surveyors are, as a rule, shrewd men, and this is a point which is not always absent from their consideration.

In these Chelsea estimates there is one fact which will certainly awaken some curiosity. Out of the ten estimates eight are for isolated installations; of these eight seven either provide for or recommend the use of secondary batteries. The remaining tender, from which batteries are excluded, came from a firm who are supposed to know more about the subject than any other private firm in the country. We are, however, informed that the firm in question were under the impression that batteries were not to be tendered for.

Apropos of secondary batteries, we are sorry to have to report—upon unimpeachable authority—that at an installation which has been described (we believe correctly) as the largest isolated plant worked with accumulators in this country, the batteries proved so unsatisfactory that their use has for some time past been entirely abandoned. The secretary of the institution in question, in reply to a letter of inquiry, writes as follows:—"We have abandoned them [the batteries] for our office illumination for some time. We now run the lights direct from the dynamos day and night, and find the result much more satisfactory." It is only fair to add that in this case the batteries were not supplied by the manufacturers whose names are most intimately associated with the construction of accumulators.

The St. James's and Pall Mall Electric Light Company, whose prospectus has appeared this week, may be warmly congratulated on the strikingly advantageous bargain which they have made with the eminent firm of Latimer Clark, Muirhead and Co. We gather from the prospectus that a provisional contract has been entered into, whereby the latter firm guarantees to provide "every requisite" for the installation of 10,000 lamps within an area of 450 yards radius from the central station, upon a low-tension direct-current system of distribution, at an estimated cost of £18,500. The Lighting Company anticipates that the profits to be derived from the installation will enable them to earn a dividend of 12 per cent., and we are more than half disposed to think that under the circumstances this ought easily to be done. But how Messrs. Latimer Clark, Muirhead and Co. can afford to carry out their part of the bargain we are totally at a loss to conceive. If, for instance, we compare the figures given by Mr. Crompton for a plant of the same output (*Electrician*, April 13th, p. 636), upon either the alternate-current or the battery system, it will be seen that the estimate for the equipment of the generating station alone with dynamos and engines considerably exceeds the figure above mentioned. Assuming that the direct-current plant costs about the same as the alternating-current central-station plant—and it is difficult to see where any considerable unbalanced economy comes in on either side—the estimate would amount to no less than £29,000 for the station alone, without taking the conductors into consideration. It should, moreover, be remarked that Mr. Crompton obtains his figures by revising the work of an earlier writer, and knocking several thousand pounds off the original estimate. If, therefore, the St. James's and Pall Mall Company can actually get the work efficiently carried out at £1. 16s. per lamp, we think that they will have abundant cause to be thankful.

Some correspondence has recently appeared in the *St. James's Gazette*, complaining of "The superfluity of educated persons" in France and in Austria. Similar complaints are of long standing in respect to Germany. In Austria, we are told, "every boy who shows any aptitude at school considers that a university career is the only one for which he is fitted." If he acts upon his convictions and attains to the grade of "Privat-docens," he usually finds that he cannot earn even the smallest pittance; and mention is made of one who, although sometime lecturer at the Technical College and the ablest mathematician of his year, was forced to become a ticket clerk on a railway. It does not surprise us, therefore, to learn that this glut of educated labour is attended with extreme scarcity of skilful artisans—those who would have become intelligent artisans being now "learned men out of work." For practical purposes, a superfluity of *un*educated persons might be preferable, and certainly would be less pitiful.

On this subject a note of warning comes to us also from America, where, it appears, numbers of English electrical students are arriving possessed of a good deal of learning, very little money, and no handicraft. The *Electrical Engineer* of New York strongly advises any who may be tempted to follow this example not to do so, lest a worse fate befal them than they have to face by remaining in their own country. Whatever the young man's educational attainments may be, one thing is absolutely essential to his candidature for a situation in the States, namely, that he "must know how to do work with his own hands, and skilfully at that, or he will find there is no room for him in an American establishment." The moral of all this is that it is high time the world's educational machinery were directed to the useful purpose of teaching people to *do* something, instead of to the superfluous task of multiplying those who can offer an opinion as to how *other* people ought to do it. Our contemporary's remarks on this subject will be found further on.

A Glasgow correspondent sends us the following extract from a local journal. As a specimen of newspaper science it would be hard to beat:—"Voltaic electricity is not intense enough for motive power; frictional, though really less powerful in proportion to means used in production, is more concentrated, hence its adoption for driving machinery, while the other, having more body if less 'go,' is used for transmission of messages over wires thousands of miles long."

The report of the Committee of Investigation appointed by the shareholders of the Pilsen-Joel Electric Lighting Company

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is one of the most astounding documents which even the chequered history of electric lighting has hitherto produced. Until the directors have been heard in their own defence it would certainly be unfair to assume that some of the more remarkable features of this indictment are not capable of explanation; we therefore postpone for the present any comment upon the financial aspects of the case, referring our readers for details to the report itself, which will be found in another page. Meanwhile, however, it is difficult to see how the directors are to escape censure for the extraordinary laxity with which the details of their administration seem to have been characterised. It may or may not have been justifiable to value Pilsen arc lamps in stock at 5s. 9d. apiece (the list price being £12, and scrap value of the metal 5s. 2d.), but it is certainly wrong to allow a central station to run short of coal because the secretary is away for the Easter holidays. The loan of £2,100 to a private firm at 1¼ per cent. per annum may possibly turn out to have been effected under such special circumstances as would render it a sound commercial transaction; but we cannot admit the wisdom, under any conceivable conditions, of running a central station, *en permanence*, without a single boiler in reserve. However, the shareholders seem fairly entitled to the consolation of believing that the financial position of the company either is, or could easily be made, somewhat more satisfactory than appeared from the recent balance-sheet.

ONE sentence in this report strikes us as peculiarly worthy of attention; it sums up in few words the whole duty of the directors (of a patent-owning company); it should be printed in illuminated letters and hung in every board room throughout the land. These are the words of wisdom:—"Under good management the value of the goodwill of the business should increase in at least the same ratio as that of the diminution of the value of the patents." This may not always be an attainable ideal, but whensoever realised it may surely be taken as *primâ facie* evidence that sound, shrewd, and honest dealings have characterised the conduct of that company. But where, alas! amongst the purveyors of electric light shall we find the limited liability concern whose directors are prepared to submit their work to such a test as this?

How little reliance can be placed on the advice of financial organs is shown in the fact that one of them, which was foremost in "bulling" the telephone stock on the strength of the Postmaster-General's speech at Wolverhampton, is now chuckling at the discomfiture of buyers in consequence of his speech in London last Friday. The first effect of this latest deliverance was to send down telephone stock rather heavily. It has since, however, almost recovered the shock, partly because it is believed that the companies can work their property in the next three years so as greatly to enhance its value; but largely, no doubt, because a State purchase in any case is always confidently expected to be advantageous to the vendor. It may be so, and we trust it will; but the opinion of financial newspapers on this point is to be received with much caution.

IN reviewing a certain work not long ago we said that the "first half of the book was fairly good and practical all through,' but proceeded to show that the second half was very much otherwise. The publishers appear to have taken the same view of our criticism, and are now using the first half of it for advertising purposes as follows:—

"Practical and good all through.—*Electrician.*"

Capital Punishment by Electricity.—The New York Assembly has passed a Bill substituting death by electricity for hanging in capital cases, by 87 votes to 8.

London, Brighton and South Coast Railway's Electric Lights.—The London and Brighton Railway Company have now fifteen trains lighted by electricity, two running between London and Brighton, and thirteen local trains.

Spanish Tenders for Telephone Service.—The Madrid *Gazette* of Saturday last contains a Royal order for tenders to be invited for the establishment and working of a telephone service in the manufacturing town of Sabadell (Barcelona).

Tenders Required for Supplying Lighting Plant.—We would direct the attention of those interested to the notice in another column of the House-to-House Company, who are asking for tenders for the supply of engines and dynamos for a central station at Kensington.

Glasgow.—The contract for the electric lighting of the New Municipal Buildings in this city which have been in course of erection for several years, has been let to Messrs. Muir, Mavor and Coulson, who will supply the current from their central station, from which also they supply the lighting current for the Glasgow General Post Office.

Royal Meteorological Society.—The usual monthly meeting of this Society was held on Wednesday evening, the 18th inst., at the Institution of Civil Engineers, 25, Great George-street, Westminster, Dr. W. Marcet, F.R.S., president, in the chair. Amongst other Papers, one on "Lightning in Snowstorms" was read by Prof. A. S. Herschel, F.R.S.

The Brussels Exhibition.—We have received from M. Bandsept, who is the electrical engineer in charge of the lighting of this Exhibition, a detailed plan showing the number and position of the lights which are to be employed. So far as it is possible to judge from this plan, it would seem that the arrangements will be of a highly efficient character.

Forthcoming Works.—Dr. William Pole is making progress with his "Life of Sir William Siemens." A selection of Sir William Siemens' scientific papers is also in the press. Prof. Tyndall has been at work on a new edition of his "Researches on Diamagnetism and Magne-Crystallic Action, including the Question of Diamagnetic Polarity." The volume in its revised form will be issued by Messrs. Longmans in a few days.

Electrolytic Reduction of Zinc Ores.—Referring to a recent note in this journal on Mr. Watt's process for the reduction of zinc ores by electrolysis, *L'Electricité* says that the same thing has been done for some years past at Saint-Denis, but that they have been unable to obtain any information as to the exact method which is followed. It is also said that successful experiments of the same kind have been made at the works of MM. Sautter et Lemonnier at Paris.

The "Otto" Gas Engine.—Messrs. Crossley Bros. have issued a new catalogue of their well-known "Otto" gas engine. This list will be found of special interest to electricians, and it describes several types of intermediate size to those hitherto built. The 20 horse-power engine has met with a large demand of late for isolated electric lighting plant. Messrs

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Crossley Bros. are also making a special feature of their combination plants, such as engine and pumps, engine and dynamo, engine and hoists, &c.

Sheffield.—At the last meeting of the Sheffield Town Council the Town Clerk read a letter from Messrs. John Tasker and Co. asking the Council to adopt the electric light in the leading thoroughfares of the town, and saying they would be pleased to do it without much profit as an introduction. The Town Clerk thought that in view of the Local Government Bill giving enlarged powers to the town, the Council would hardly sanction any such arrangement as that suggested at present. On the motion of Mr. F. P. Rawson the communication was referred to the Watch Committee.

Cables for Alternating Currents.—The Grosvenor Gallery Company have recently been testing an anti-induction electric light cable, in an underground conduit, in which were also several telephone wires. The results were most satisfactory. The cable contains a 19-strand wire, well insulated; around this is a copper sheath, which is also highly insulated; the strands and the sheath form the lead and return wires. When the copper sheath was *not* used as the return there was great induction, but the telephone remained absolutely silent when the copper sheath was utilised.

Arc Lamps in Lanterns.—In connection with a Paper read by Mr. Norman Lockyer before the Royal Society on the 12th inst. a small "Brockie-Pell" arc lamp, taking a current of about 5½ amperes, was used for projecting the illustrations. Notwithstanding the small current used on this occasion, the experiment was a marked success, and the absolutely steady, silent light given by the lamp was greatly admired by those present who take an interest in such matters. The apparatus was supplied by Messrs. Drake and Gorham, and the current was obtained from the accumulators used for lighting the hall.

Taunton.—At a meeting of the Taunton Town Council on Tuesday it was proposed to light the whole town by electricity. A memorial signed by 700 of the inhabitants was presented in favour of the scheme. It was explained, however, by the chairman of the Finance Committee that in view of the extra expense which would be incurred by the sewage works the increased lighting could not be provided without materially adding to the rates, and this view was adopted by several members present. The proposal of the Lighting Committee to extend the electric light was ultimately defeated by eight votes to seven.

University College, Bristol.—This college reopens on 25th April. The work in the engineering department during the coming term will be largely of a special character. Prof. Ryan will lecture on Civil Engineering, Mining Engineering, and Electrical Engineering. The last-named course will comprise electric lighting, dynamo electric machinery and transmission of power. Civil engineering students will attend Prof. Lloyd Morgan's practical Geology classes in the field, and Mr. Selman's outdoor exercises in Surveying. Electrical engineers and others will occupy themselves in the chemical, physical, and engineering laboratories of the college.

The Telegraph Service.—In the House of Commons on Friday last Mr. Raikes, in answer to Mr. Handel Cossham, said he did not propose to reduce the ordinary attendance of civilian male telegraphists from 50 to 48 hours per week, or to pay them extra for work done on Sunday. Their present pay was fixed so as to include remuneration for 50 hours' work a-week, namely, 48 hours on week days and two on Sundays. In reply to Mr. A. O'Connor, Mr. Raikes said that at the present time there were over 60 vacancies in the first class of telegraphists at the Central Telegraph Office, 40 of which were due to an augumentation of the establishment since the estimates were prepared. Promotions had recently been made, and further promotions would be made in due course during the financial year. The expenditure for salaries paid to telegraphists at the Central Telegraph Office would, he believed, approximate very closely to the estimate.

Paris Universal Exhibition, 1889.—A circular, issued from the Mansion House, states that the applications from intending exhibitors for space in the British Section of this Exhibition ought all to be sent in before the end of the present month, addressed to the Offices of the Section, 2, Walbrook, E.C. They have been asked for thus early in order that the executive council of the section may be able to form an approximate idea of the actual amount of space which they should take over from the French authorities. Applications received after the 28th inst. will not be refused; but they can only be entertained subject to the possibility of space being found for them, and the total area required for the British Section will be calculated on the amount applied for before that date. Up to the present a satisfactory number of applications have been received, and the executive council anticipate that the whole of the space which can be placed at their disposal will be fully occupied.

Communication with Lighthouses.—On the 12th inst., at the Board of Trade, Sir Michael Hicks-Beach received a deputation from the Associated Chambers of Commerce. The object of the deputation was to solicit Government aid in the establishment of national harbours of refuge, the abolition of light dues, and improved communication with lighthouses.—Sir Michael Hicks-Beach, in replying, said he had understood that the important question they intended to bring before him was the question of the effect of communication with lighthouses, lightships, and telegraph stations. He found that the United States, at any rate, had no such communication. In Germany there were only three places in communication, and there was no communication with lightships. Still, he did not mean to say that this precluded them from taking measures in this direction. He knew of no instance of telegraph communication having led to the saving of life or property. Attention had been called to the acquisition by Lloyd's of signalling stations. They had not heard of this proposal this year, or he would be disposed to look upon it favourably. He certainly believed there was a great danger as to life and property through the present difficulty of obtaining sites for stations.

Thermal Variation in Daniell Cells and Accumulators.—The February number of *Wiedemann's Annalen* contains a paper on this subject by G. Meyer. The author finds that the E.M.F. of a Daniell (H_2SO_4) cell increases with the temperature. The temperature-coefficient, E.M.F./temperature, depends on the degree of concentration of the fluids in the cell, increasing as the solution of H_2SO_4 becomes more concentrated, until the solution attains a strength of 30 per cent., when it reaches a maximum, and diminishes when the acid solution becomes still further concentrated. The temperature-coefficient increases steadily as the concentration of the $CuSO_4$ solution increases. In the case of the $ZnSO_4$ cell, the E.M F. falls as the temperature rises, and the result of diluting the $ZnSO_4$ solution is that the temperature-coefficient, which is negative for a moderately concentrated solution, passes through zero, and attains a positive value. Increasing the concentration of the $CuSO_4$ solution has the same effect as in the case of the ordinary H_2SO_4 cell. With regard to accumulators, the author finds that there is no perceptible change in the E.M.F. when the temperature is varied. The method of measurement adopted did not enable him to deter-

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mine whether the E.M.F. varies with the concentration of the acids, owing to the complication introduced by the fact that as soon as the charging current ceases the E.M.F. begins to fall rapidly at first and afterwards much more slowly. Streintz and Aulinger have shown that this is due to oxidisation of the lead plates.

St. James's Vestry and the Electric Light.—At the last meeting of the St. James's Vestry the Lighting Committee recommended that the consent of the Vestry be given to the St. James's and Pall-mall Electric Lighting Company applying to the Board of Trade for a licence under the Electric Lighting Act, 1882, subject to the company agreeing to the modifications made by the committee in the draft licence, and to any alterations being made in the clauses relating to technical questions which the Board of Trade may require. Mr. Winnett hoped the Vestry would pause before adopting this recommendation. Again and again electric lighting companies had tried to get possession of the area which this company also desired to be compelled to light. Why was it that this part of the parish of St. James was always so much coveted by these companies? Because it was the most valuable for electric lighting of any district in London. When the companies were asked to include other parts of the parish under the compulsory clauses they always politely but firmly declined. The Vestry had received very short notice of this matter, and it behoved them to inquire closely into the constitution of the company before handing over to it a valuable district with the exclusion of others. It was all very well for a company to propose to light this district; it was quite another thing to do it. One company which had applied to that Board had spent a hundred thousand pounds on the endeavour to make this kind of electric lighting supply a commercial success. Yet they had failed. What probability was there that this new company would be more successful? He trusted the Vestry would at least take more time to consider the proposal. Mr. Tapping took the same view as Mr. Winnett. Mr. W. Jenkins defended the action of the committee. Mr. Dixey moved, and Mr. Osborn seconded, that the matter be referred to a committee of the whole Vestry for further consideration. This was carried.

"Don't."—The following editorial appears in the current number of the *Electrical Engineer* of New York:—"The great activity prevailing in this country at the present time in the principal electrical industries is very naturally attracting the attention of many young men abroad, especially in England, who after graduating from some technological institution, and providing themselves with unexceptionable letters of introduction to some one in New York, speedily find their way across the Atlantic, in full confidence that remunerative employment awaits them immediately upon arrival. Our transatlantic contemporaries cannot do many of these young gentlemen a greater service than to pursuade them, if possible, to accept and act upon the celebrated advice of *Punch* to those about to marry. While it is true that most of these persons ultimately find employment in some capacity or other, yet not a few have been compelled to undergo experiences which are, to say the least, exceedingly humiliating to a sensitive soul. Many of them are supplied with barely more than enough money to land them in New York; they then learn, to their dismay, that almost all the electrical establishments of importance are situated at distances varying from 200 to 1,000 miles or more from the metropolis, and can only be reached by an expensive railway journey. They further find, usually to their very great astonishment, that their letters of introduction and of recommendation, so indispensable in Europe, are of little more account on this side of the ocean than so much waste paper. A man in this country always expects to apply for a situation on his own merits. 'Influence' goes for little or nothing. If an employer happen to have a vacancy, and the applicant appear to be capable of filling it, he is likely to have a chance to try, even though he may be an utter stranger. If he were backed by a personal letter from the President of the United States it would, as a rule, make very little difference. One thing is absolutely essential—the candidate must know how to do work with his own hands, and skilfully at that, or he will find there is no room for him in an American establishment. We do not say this to discourage our English cousins, for we are well aware that many of the most successful electrical engineers in America have come here as young men from across the seas. But it will save much disappointment if those who may come hereafter start with a definite conception of the industrial conditions and customs of this country, which differ so widely in many respects from those to which they have been accutomed at home."

An Early Inventor in Electric Lighting.—The Rev. G. H. Staite, vicar of Sutton Cheney, Hinckley, writes to the *Pall Mall Gazette* as follows:—"Knowing your love of fair play and readiness to ventilate hidden grievances, I venture to ask the insertion of this letter, in the belief that if the facts were known some among your many readers would be inclined to entertain the claims of the family of a man who spent his life and fortune on a recognised public work of the greatest importance. My father was the originator of electric lighting, his exhibitions extending from 1847 to shortly before his death in 1854. During that interval he expended a considerable fortune, and left his family penniless. There are at the present time his widow, aged eighty, two daughters, and myself. That our claims to recognition are not unfounded will be seen from the following testimony:—Prof. Tyndall—'Fragments of Science,' Vol. II., p. 424: 'To keep the carbons at the proper distance as under regulators were devised, the earliest, I believe, by Staite.' 'Haydn's Dictionary of Dates,' later editions, 'Electric Light:' 'Apparatus for regulating the electric light were devised in 1846 and shown by Staite and Petrie in 1848.' Urquhart, 'Electric Light:' edited by Webb, 1880, p. 161: 'Staite and Edwards patented an electric regulator based upon the heating and expansion of metals by the current to be regulated. This idea, beautiful in tself, is really the original of the regulators used to-day, and the self-same principle is employed by Mr. Edison.' And 'Dr. Siemens,' page 173: 'Staite as early as 1847 patented a lamp in which the lower carbon is controlled by a movable soft iron core acted on by a hollow electro-magnet.' Fontaine and Du Moncel gave similar testimony. The priority of the principle of automatic regulation, the *sine quâ non* of electric lighting, was decided in my father's favour by the French Academy of Sciences, as recorded in *Le Courrier Français*, February 4, 1849. Of his many patents and improvements no use could be made by his family; practically, as far as they were concerned, they died with my father, although they were and are still available for subsequent workers in the same field. His family feel that they have entirely lost their fortune through his public enterprise. All their money, consisting of thousands of pounds, was sunk, and by the premature death of the inventor in his forty-second year his and their hopes of any pecuniary return were irretrievably lost. It is this combination of facts which induces me to write this appeal, every point of which I shall be most glad to substantiate should any one be kindly induced to notice it."

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NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

(*Continued from page 593.*)

The next subject which claims attention is the method of experimentally measuring the *power* taken up in inductive circuits traversed by periodic currents. There are amongst others two instruments especially useful for measuring periodic currents. One of these, the Cardew voltmeter, depends upon the principle that when a wire traversed by a current either steady and unidirectional or steadily periodic is placed in an enclosure, the walls of which are approximately at a constant temperature, the wire will itself after a short time attain a constant temperature. This constant temperature is reached when there is a state of equilibrium between the rate at which heat is radiated by the wire and the rate at which the walls of the enclosure radiate heat back to it.

The wire has a definite length corresponding to each temperature, and means are provided for measuring this elongation with great accuracy. The total amount of heat generated in the wire per second is dependent upon the rate of generation at each instant. This instantaneous rate of heat development is by Joules's law equal in mechanical units to the product of the ohmic resistance and the square of the instantaneous current strength.

If the wire is traversed by a simple periodic current, and we construct from the current curve diagram another curve, whose ordinates are equal to the square of the corresponding current ordinates, we have a curve every ordinate of which is proportional to the instantaneous rate of generation of heat in a wire traversed by the periodic current. Since the horizontal line measures time, it is obvious that the whole area of the outer curve, or heat curve, represents the total work done per semi-period by the current in producing heat, and that the same total work would be done by a steady current whose value was the square root of the mean of the squares of all the ordinates of the periodic current curve.

This square root of the mean of the squares of all the ordinates of a simple periodic curve has, however, been shown on p. 284 to be numerically equal to the value of the maximum ordinate of the periodic curve divided by $\sqrt{2}$. It follows that the total heat generated per second in the wire is a numerical measure of the half the square of the maximum value of a simple periodic current. A fine wire stretched out in the manner of a Cardew voltmeter wire has a very small inductance, and hence, when acted upon by a simple periodic electromotive force, the current produced in it is very nearly proportional to this impressed electromotive force. It follows then that when a Cardew voltmeter is subjected to a simple periodic E.M.F. the needle takes a definite position, corresponding to a definite expansion of the wire, which is that which it would take if the wire were subjected to a steady electromotive force equal to $\frac{1}{\sqrt{2}}$ of the maximum value of the periodic electromotive force.

The Cardew voltmeter is not adapted to measure any but very small currents. The instrument generally employed to measure periodic currents of moderate and large magnitude is some modification of Weber's electro-dynamometer. In the best-known practical form of Siemens there are two coils of wires in series, one fixed and the other movable, and so placed that the currents in the movable coil circuit are traversed at right angles by the lines of force due to those in the fixed coil. When a simple periodic current traverses the coils in series, a force is brought into existence due to the electro-dynamic action, and which is proportional to the instantaneous value of the square of the current strength. From instant to instant, however, the current strength varies. If the time of free vibration of the moveable coil is very large compared with that of a complete period of the electrical vibrations, and if the movable coil is brought back by a restoring force due to a spring or bifilar suspension or gravity, &c., into a fixed normal position, then, during one complete electrical period, we may consider that the movable portion receives a number of small impulses which are in magnitude represented by the square of the ordinates of the current wave. Hence, the total impulse on the movable coil is equal to the magnitude of the integrated area of a wave curve whose ordinates are respectively the squares of those of the current curve, and the mean force on the movable coil will obviously be proportional to the mean ordinate of this force curve. If the movable coil is so heavy that its time of free vibration is very long compared with the time in which the periodic forces on it run through a complete cycle, it will experience a displacement exactly that due to the mean of the forces acting upon it—that is, to the square root of the mean of the squares of these instantaneous currents—or to $\frac{I}{\sqrt{2}}$, where I is the maximum value of the current during the period. The periodic force on the movable coil is equivalent to a steady force, when this periodic force runs through all its values in a time very short compared with the time of free vibration of the coil. Hence, if a simple periodic current has a maximum value I, when it is sent through an electro-dynaommeter it will cause a deflection equal to that which would be caused by a steady current equal to $\frac{I}{\sqrt{2}}$.

Let us suppose a coil of constant inductance L and resistance R to be traversed by a simple periodic current of frequency n (where $2\pi n = p$). Let an electrodynamometer be inserted in series with it, and let a Cardew voltmeter be connected to the extremities of the inductive circuit. Under these circumstances many persons have and do suppose that the product of the readings of the voltmeter and dynamometer gives the *power* taken up in the induction circuit. From what has gone before we now see that this cannot be the case, for even *assuming for the moment* that the Cardew voltmeter gives a reading indicating truly the square root of mean of the squares of the periodic potential differences between the two points to which it is connected, the product of Cardew reading and the dynamometer reading does not give the power, since it takes no account of the difference of phase of the current and impressed E.M.F.

We have above seen that if E and I are the maximum values during the period of the impressed E.M.F. and current in an inductive circuit, then the *power* taken up in that circuit is equal to $\frac{EI}{2}\cos\theta$, when θ = angle of lag of current behind the E.M.F. But the reading of the Cardew voltmeter when connected to the ends of an inductive circuit is very nearly proportional to $\frac{E}{\sqrt{2}}$, and the dynamometer reading in that circuit is proportional to $\frac{I}{\sqrt{2}}$; therefore, the product of these readings is proportional to $\frac{EI}{2}$, and takes no account of the difference of phase. For this reason we can derive no information from the use, in this manner, of these instruments. A very small error, in practice negligible, is introduced by disregarding the inductance of the wire of the Cardew instrument. On this account strictly speaking currents in the wire cannot be taken as accurately proportional to potential differences at the extremities, but this is in ordinary usage a neglectable error.

(*To be continued.*)

LARGE SWITCH-BOARDS FOR DISTRIBUTION WORK.

We have recently had the pleasure of examining a very large switch-board which the United Electrical Engineering Company (Limited) have constructed to the order of the Aluminium Syndicate, who are introducing the process of Dr. Kleiner, by which the direct electrolytic reduction of the metal from fused cryolite is effected. The switch-board has been built, under the direction of Mr. Nevile, to distribute the current from a group of four dynamos. One of these four machines is of

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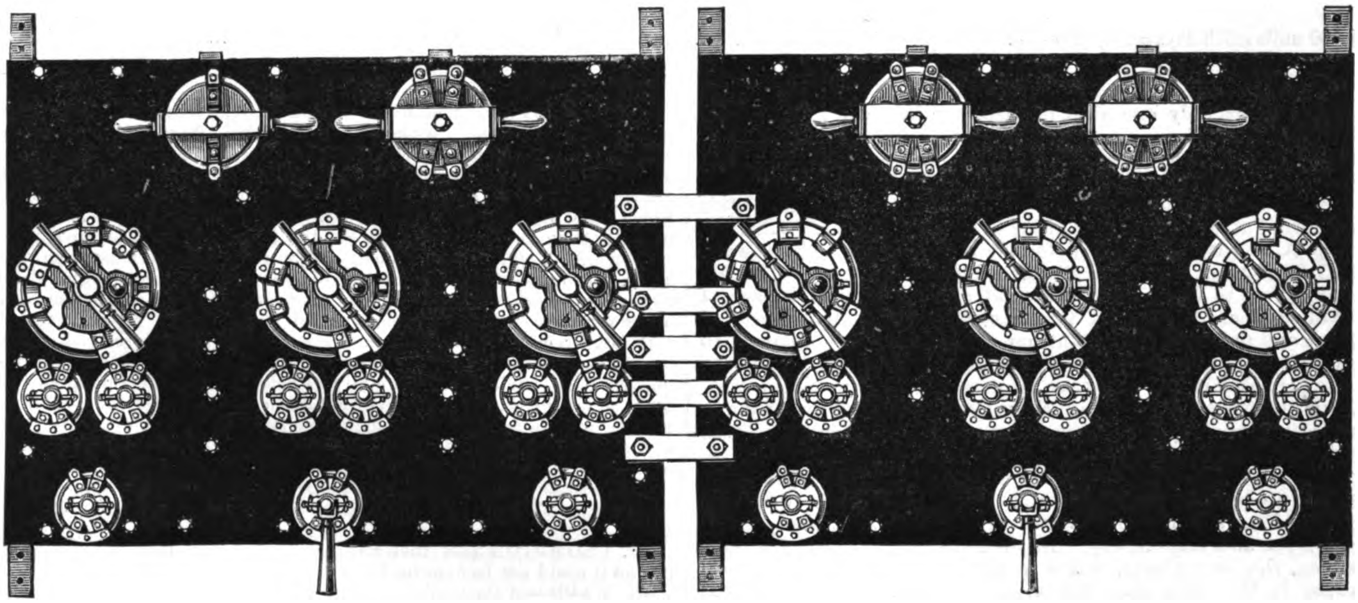
higher E.M.F. than the others, and is used for starting the operation upon any one of the eighteen separate crucibles which the switch-board is intended to control. At a certain point in the process, when the cryolite has become fused, a lower E.M.F. is sufficient to carry on the reduction.

The switches are mounted upon a slab of slate measuring 11ft. in length by 4ft. in height, and raised 5in. from the wall by means of side battens. The large switches seen at the top are one double-break on and off switch for the high-tension dynamo, to carry 500 amperes, and three two-way switches for 1,000 amperes each. The six crucible switches below are of special design, and are constructed to transfer a crucible from the high-tension to one of the low-tension dynamos, at the same time connecting the high-tension dynamo to a resistance, and removing a resistance from the low-tension dynamo, the object being to keep the load upon the engine gearing and dynamos approximately constant. The 18 lower switches are close-contact two-way switches, each controlling one crucible and allowing the current to each crucible to proceed to it either direct from the dynamo or by way of one of the above special switches. By this arrangement 18 or more crucibles can be controlled six at a time by means of the special switches. Provision is also made for an addition either to the number of dynamos in use or to the number of crucibles operated by each machine. The switches, which are of very substantial make, are furnished throughout with Drake and Gorham's adjustable ring contacts, and all of them are of the double break type. The whole of the details have been carried out in a manner which reflects the highest credit upon the United Electrical Engineering Company.



Large Switchboard for Distribution Work constructed by the United Electrical Engineering Company.

CENTRAL STATION LIGHTING.—TRANSFORMERS v. ACCUMULATORS.*

BY R. E. CROMPTON.

(Concluded from page 637.)

Comparison of Working Cost and Maintenance; Coal Bill of the A.T. System.—The generating plant on the A.T. system has to run continuously—that is to say, that the larger engines will be run for an average of three hours per day, and if it be found practically possible to subdivide the plant into a number of engines, and work them parallel, as is the case with the direct-current system, we may be able to credit the engines and dynamos with an efficiency of 75 per cent. during these hours. In order to meet the average demand of 2,100 units per day, the load diagrams show that they will vary during these hours from 400 to 720 kilowatts. We have as yet been furnished with no actual data as to the actual efficiency of the alternating-transformer system at various rates of output—that is, the E.H.P. actually delivered to the lamps, divided by the E.H.P. at the terminals of the dynamos. It must be recollected that, as the transformers must be large enough to supply the maximum demand of each house, whereas the maximum demand that the station can supply is probably not more than one-third of this, the transformers during this period of three hours cannot be more than one-third loaded, and therefore it is not probable that their efficiency is more than 70 per cent. It follows that, during the hours when the plant is working at 500, 400, and 300 kilowatts, the total efficiency—that is, E.H.P. delivered at the lamps, divided by the I.H.P. in the engine cylinders, including loss in mains, will not be above 54 per cent. Supposing that the steam engines can work at 2½lb. of coal per I.H.P., the net quantity required per E.H.P. will be 4·65lb., or 6·21b. per kilowatt. The output during these hours may be considered as 60 per cent. of that of the whole day, or, say, 1,260 kilowatts, therefore about 70cwt. will be used during these three hours. During the remainder of the 21 hours the transformers will be working at a very small rate of output. It is probable that their efficiency will be reduced to 30 per cent., and the efficiency of the steam engines and dynamos to 50 per cent., or a total efficiency—that is, E.H.P. at the lamps, divided by the I.H.P. of the engines—of 15 per cent. only; therefore, during this period it seems probable that 17lb. of coal will be used per E. H.P. or 22·5 per kilowatt. Therefore, the coal used in producing the balance of the daily output of 840 kilowatts will be about eight tons eight cwt., or, making a small allowance for the lighting up of boilers, 12 tons per day. The oil, water, and petty stores may be calculated at 7s. 6d. per hour for three hours during the day, and at 1s. per hour during the remainder of the time. Therefore, the total cost of material used in running this station will be £4,849. The B.T. system, on the other hand, will show great saving on this. For the output of 2,100 units, it will be sufficient to work the generating plant for about five hours at approximately its greatest rate of efficiency. I have had ample experience with this class of plant, and know that we can in actual practice produce the E.H.P. at the terminals of the dynamo with the expenditure of 3½lb. of coal. Taking the maximum loss in the accumulators, the efficiency of the system—that is, the E.H.P. at the lamps—divided by E.H.P. at the terminals of the dynamo, will not be less than 80 per cent.; therefore, we may say that each unit at the lamps can be produced for 5·75lb. of coal, or five tons eight cwt. per day, or allowing a 25 per cent. margin for contingencies, 2,550 tons per annum. The water and petty stores may in this case be taken at 5s. an hour for 1,400 hours; the total cost of the material for producing 2,100 units by the B.T. system will be £2,517, or only about 57 per cent. of the cost of material by the A.T. system. *Turning now to the labour in the engine room,* the table before you shows that, as in the case of the A.T. system, the hours are continuous, three shifts of men will be required, it is necessary to have two foremen, six engine drivers, and nine firemen, whereas in the B.T

* Paper read before the Society of Telegraph-Engineers and Electricians on Thursday, April 12th, 1888.

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TABLE No. 4.

WORKING EXPENSES AND MAINTENANCE OF 10,000-LIGHT, OR 600-KILOWATT, PLANT.

——	A.T.		B.T.	
Materials—	£ s. d.		£ s. d.	£ s. d.
Coal: 4,380 tons at 17s.	3,723 0 0			
,, 2,550 ,, 17s.	...		2,167 0 0	
Oil, water, and petty stores: 1,500 hours at 7s. 6d. + 7,250 hours at 1s.	925 0 0		...	
,, ,, 1,400 ,, 5s.	...		350 0 0	
Total cost of material		4,648 0 0		2,517 0 0
Labour—				
2 foremen drivers at 45s., 6 drivers at 30s., 9 firemen at 24s.; sundry labour	1,388 8 0		...	
foreman driver at 45s., 2 drivers at 30s., 3 firemen at 24s.; sundry labour	...		975 0 0	
Salaries—				
1 chief at £500, 2 assistants at £200 each, 4 clerks at £80 each	1,220 0 0		...	
1 chief at £500, 1 assistant at £200, 4 clerks at £80 each	...		1,020 0 0	
		2,608 8 0		1,995 0 0
Maintenance of Plant—				
Motive-power and dynamos: 10 per cent. on £18,010	1,801 0 0		...	
,, ,, 10 per cent. on £13,400	...		1,340 0 0	
Buildings and fittings: 5 per cent. on £11,000	550 0 0		...	
,, ,, 5 per cent. on £8,000	...		400 0 0	
Transformers: 10 per cent. on £7,500	750 0 0		...	
Accumulators: 15 per cent. on £9,600	...		1,440 0 0	
Mains: 7½ per cent. on £20,430	1,532 5 0		...	
,, 2½ per cent. on £26,262	...		656 10 0	
Regulating gear: 10 per cent. on £500	50 0 0		...	
,, ,, 10 per cent. on £2,500	...		250 0 0	
		4,683 5 0		4,086 10 0
		11,939 13 0		8,598 10 0
2,100 units × 365 days = 766,500 units. Cost per unit		3·75d.	...	2·7d.

system there is only one shift of men, one foreman, four drivers, and three firemen are employed. I have only estimated for two extra men in the engine room for the A.T. system, but for the B.T. system I have allowed for four accumulator foremen in charge of the four accumulator stations, and two messengers. The totals thus arrived at for labour for working the systems are £1,389. 8s. 8d. for the A.T. system, and £975 for the B.T. system. The salaries are £1,220 for the A.T., and £1,020 for the B.T. system. The last item we come to is one for *repairs and renewals*. In both cases I have allowed at the rate of 10 per cent. on the motive power of engines and dynamos, 5 per cent. on the buildings and fittings, 10 per cent. on transformers, 15 per cent. on accumulators, 7½ per cent on the insulated mains that have to carry 2,000 volts, 2½ per cent. only on the bare copper mains, the majority of which only have to carry 110 volts, 10 per cent. on all regulating appliances. Thus, nearly the heaviest item, the *maintenance*, comes to £4,683. 5s. in the A.T. system, and £4,086. 10s. for the B.T. system. The gross cost of producing 776,500 units by the A.T. system would be £11,939. 13s., and the B.T. system would be £8,598. 10s., or 3·75 and 2·7 per unit respectively. In order to make a fair comparison between the two plants, when worked in the most economical manner, if the generating station of the B.T. system is worked longer hours it can actually produce the daily average of 3,600 units named by the writer in *Industries*, and in order to do this the sole increase in the working expenses would be in the materials, to which £1,800 would have to be added. The cost then, of 1,314,000 units, would be £10,398. 10s., or 1·9 per unit by the B.T. system.

It will be seen, therefore, that while by both systems there is a probability of a fair return on the capital expenditure, yet in almost every respect the B.T. system is a more economical one. This arises from the fact that the main cause of expense in the A.T. system, depending, as it does, on continually moving machinery, is the heavy cost of material, labour and superintendence during the long hours in which the machinery is working very lightly loaded. The B.T. system shows very favourably in this respect, as even at the latter increased output of 3,600 units per day the machinery need not work on the average more than ten hours, so that one shift of men can do the work, and there is ample time for repairs and inspection of machinery.

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DISCUSSION. THURSDAY, APRIL 12.

Mr. KAPP thought that if the makers of batteries had searched from one end of England to another they could not have found a better advocate than Mr. Crompton, because he thoroughly believed in accumulators. Even when some years ago the Victoria installation was planned, he intended to use them, but they had not been put in because they were not reliable at that time. He (Mr. Kapp) was very glad to hear that they were reliable now, though it was a surprise to him. He congratulated the makers of accumulators on the paper, because it would give contractors for, and users of, the electric light more confidence in these appliances. Although he differed from Mr. Crompton, he admired the very able and plucky way in which he had fought the battle of the accumulators against the transformers. Mr. Crompton said that 3,600 units per day was too much for a plant which could supply a maximum of 600 kilowatts at the lamps. According to the London diagram it was so, but the Boston diagram showed 3,000 or even 3,600, and the Cincinnati diagram was not very far from that figure. The reason why the London diagram was smaller was that there were very few offices on, and probably not many theatres and public halls where the lights were on for many nights in the year. He quite agreed with Mr. Crompton that people had generally overlooked the fact that a conductor consisted of something more than copper. The cost of the insulation itself ought to be carefully calculated, but Mr. Crompton had gone too far the other way, having put down a higher cost for insulation and laying than necessary. A high-class lead-covered cable of half-square inch section cost about 13s. per yard, and for the double conductor £130 per 100 yards. Such a cable could be laid straight into the ground; the only protection necessary would be to cover it with rough plank and fill the trench. That would bring the cost up to a total of £155, and not £187.

Mr. CROMPTON said that £187 was what had been paid for doing it, and it could not be done for less.

Mr. KAPP said the insulation of a lead-covered cable would be reckoned by hundreds of megohms per mile, while the insulation of Mr. Crompton's mains could hardly be 1,000 ohms per mile. A Berthoud-Borel cable of 155 square millimetres costs at the present advance in copper £40, or £80 for the double main, and £105 for the main laid. Mr. Crompton's main of only a slightly larger section cost £100. There then was a saving of 5 per cent., but was it worth while for so small a saving to give up a main the insulation of which was measured by megohms, and adopt one in which it was measured by hundreds of ohms only? Of course if Mr. Crompton's system was absolutely perfect it might be worth while, but he (Mr. Kapp) would not care to be the engineer in charge, and be responsible for the maintenance of these mains. He was opposed to the plan of having a network of high-pressure mains throughout the whole district; he preferred a network of low-pressure mains, with only a few high-pressure feeders going to stated points. In that way, instead of 20,000 yards of high-pressure cable, there would be only a comparatively short system of such feeders, and along the network of distributing mains there would be a certain number of transformers—ten or twelve. Mr. Crompton took distributing mains of ¼ square inch section, and fed them from four local batteries, which were to be installed in mews as near as possible to the line of lighting; but in that case there were either too few batteries or there was too small a section of main. It was evident that the fewer the points at which the network of mains was fed the larger must be the section to be able to take the currents without serious loss of potential. Mr. Crompton had mentioned four volts as the maximum variation allowable. That was too much. He doubted whether the British householder would put up with the same variations of light as he used to do with gas. A little latitude—say, one volt—must also be allowed the imperfections of the regulating apparatus. We thus get 5 per cent. variation in pressure, and this is objectionable, because it means 10 to 15 per cent. variation in light. The speaker thought something like two or three volts should not be exceeded. It was a very difficult matter to settle what size of main was necessary in a given district. It depended

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on the configuration of the place, because advantage must be taken of the carrying capacity through cross streets. It was impossible to say offhand whether a ¼in. main was enough for a 600-ampere current or not, but taking Bradford as an example, they would find by consulting the specification that about 3,000 lamps would be installed, and the whole current would have to be supplied through three feeding centres, making 1,000 lamps depending on each. The main to be used there was ·177 square inch area, and the variation permitted was two or three volts. With a main of a quarter square inch it would be possible to supply 1,400 lamps, or 4,200 from three centres. To supply 10,000 lamps continuously burning nine or ten feeding centres would be required, and in Mr. Crompton's system advantage could not be taken of the interlacing of the network, as in a simple two-conductor service. To make up for the loss of carrying capacity of cross connections Mr. Crompton would have to use more local centres, and install at least ten battery stations if he wished to retain the quarter square inch mains and not exceed the variations of pressure, which in the case of Bradford Mr. Shoolbred had limited to about two or three volts. For such a number of centres six more attendants would be required, and at £100 a year each there would be an extra £600 working cost. If Mr. Crompton wished to retain the four-battery centres, then, instead of a main of a ¼ square inch he would have to use one of 1½ square inch. That would come to about £200 per hundred yards, so that the estimate would have to be increased by £20,000. The maintenance would also have to be increased by £1,532, and it would probably be cheaper to subdivide the battery into ten local centres, and have more attendants. He wished to ask Mr. Crompton whether, in his estimate, he had included rent of rooms for the accumulators? He had told them that he could not put a drain pipe through private property, but he wanted to put on private property a whole set of batteries containing sulphuric acid. The rent would cost at least £500 annually, and the wages of the six additional men would raise the amount to £1,100 a year. But if the ¼ square inch main were adopted, and the accumulators were fed by alternate transformers, ten in number, each capable of supplying a maximum of 1,000 or 1,200 lights, the rent would be insignificant, and nothing would have to be paid for attendance. Mr. Crompton said he was ready to supply batteries at the figures he had quoted, and he (Mr. Kapp) knew there were many people who would be willing to supply 10 transformers, each of 1,000 or 1,200 lights, for £3,000, as against the estimate of £7,500. The space occupied by each transformer would not exceed about 20 cubic feet, and it would not be very difficult to find accommodation for it in a chamber lined with cast iron under the footway, or in a small fireproof room on mews property. He was rather inclined to think that the author had underestimated the cost of batteries. His authority for this statement was Mr. Crompton himself. A few months ago he asked that gentleman what in his opinion would be the cost to be allowed for batteries which should have a very rapid discharge; and from the figures then supplied he found that the cost would be £30 per kilowatt, but according to the paper it would only be £15 to £16. Was there any maker who would supply a battery giving for a short time and without being injured 10 kilowatts at £160? Mr. Crompton's comparison of the two systems as regards efficiency was very unfavourable to the alternating transformers, assuming, as he did, that a transformer one-third loaded could not have more than 70 per cent. efficiency. That was merely an assumption, for Prof. Ayrton had given them the results of some experiments with a two horse-power transformer which when working at 318 watts, or a fifth of its full output, gave 80 per cent. efficiency, while at one-third of the full output the efficiency was 85·8 per cent. It was not necessary to work transformers at less than one-third of their output. If 20 per cent. loss were allowed in the feeding mains (which would be a very economical way of working) there would then be the 20 per cent. to draw upon when the transformers were working with smaller output, so that there was a tendency for the loss in one apparatus to be balanced by the gain in the other. If they worked with a reasonably large output it would not be found so bad as Mr. Crompton made out. He wished to ask a question about the regulation. When batteries were worked in private installations 2½ volts per cell were allowed for charging and 2 volts were obtained in discharging. How could Mr. Crompton insure constancy of potential whether he was charging or discharging? As far as the speaker knew, there were two methods available. They could either couple the lighting circuit to the local centres through rheostats, which must continuously be adjusted in accordance with the demand—and this method, as they all knew, is in use in the Edison stations, but it, of course, entails a certain waste of energy—or they could change the number of cells coupled between the lighting circuit, and thus they could regulate the pressure. But, in that case, some of the cells would get charged and discharged differently from the others, and he wanted to ask Mr. Crompton how he would protect those cells from injury under this treatment?

Mr. PARKER (of Wolverhampton) said he had listened to Mr. Crompton with a great deal of pleasure, especially to his efforts to make clear the cost of the cables and various parts of installations. He was not a recent convert to batteries, and as his firm was turning out 5,000cwt. of batteries per year he had had considerable experience with them. He did not take much exception to the figures which were given in the paper as to the cost of batteries, but though Mr. Crompton alluded to Vienna he did not say what was done there. A matter of 400 or 500 volts did not appear to be a sufficient pressure to work the batteries with if a comparison was made with the other system. The effort made some years ago at Colchester seemed to have fallen out of notice. The reasons as to the failure of that installation did not seem to have been carefully studied. The first reason appeared to be the insufficiency of the number of lights attempted, and the second the mode of insulation used in the cells, which were not so good then as now. He would like to send some cells from Wolverhampton to be tested against anything Mr. Crompton could find. He had just lately been able to carry out some improvements which would shortly be made public, and which would enable them to give much more life to accumulators, and to discharge at a more rapid rate. He did not think more had been done at Vienna than at private installations. The manipulation of a battery station was the difficulty, and he did not see that the cost stood in the way at all. The battery system could be carried out very much at the same cost as an alternate-current system, and possibly might be preferable. Perhaps one of the most unique experiences was at Eastbourne, where the installation of alternate-currents had been running for nearly two years, and there had been no accident or mishap, and the machine had run without any stoppage or cessation of light. He had mentioned these points, not with the view of throwing up any fireworks, but as Mr. Crompton had described what he had done he thought it as well to state what others had done.

After a few observations from Mr. W. H. PREECE the discussion was adjourned until the Thursday following (last night), with the understanding that Mr. Preece would then resume his speech.

(To be continued.)

REPORT ON LIGHTING THE CHELSEA TOWN HALL BUILDINGS WITH ELECTRIC LIGHT.

The following is the full text of the report presented to the Chelsea Vestry Hall Building Committee by Mr. G. R. Strachan:—

"Ten electric lighting companies were asked to give estimates of the cost of laying plant and providing the necessary lamps, apparatus, &c., for lighting the Town Hall with the electric light; and, for their guidance, the following standard of light was given:—

Town Hall	3,200 candle-power.
Council chamber	350 ,, ,,
Platform ante room	Light in same proportion to above.
Committee room	
Lower hall	
Main corridors	

In all other matters the firms were given a free hand to tender as they deemed best. The whole of the firms responded to the invitation. Eight of them proposed to supply the light by a separate installation on the premises, and two of them—the local companies—proposed to supply the current from a central generating station. Of the eight who proposed to supply a separate installation, two proposed the use of gas engines and six the use of steam engines to drive the dynamo.

"If a separate installation is laid it will be necessary to have an engine and dynamo working on the premises. Some amount of vibration will be experienced in working them, but with first-class machines and a solid foundation it may be reduced so as not to be an annoyance. One of the firms—Messrs. Drake and Gorham—have tendered for a duplicate set of engines and dynamos, so as to have provision at hand in case of a breakdown. The other firms have either included accumulators in their estimates, or have expressed the opinion that they should be provided. An accumulator acts the part of a gasometer for the electric light. The energy is stored in it, so as to be at call when a breakdown occurs. It also ensures steadiness of the light. Insulated wire cables would be laid from the accumulators and dynamos to the rooms to be lighted to convey the current to the lamps. Switch-boards would be fixed to enable the currents to be turned on to the different rooms at will. In the Town Hall itself the lamps would be connected to two circuits, so that, in the event of an accident to either of the circuits, half of the lamps would be in lighting. The cables and wires would be provided with cut-outs. These are, practically, short pieces of metal, which fuse if the wires or cables get heated, and so cut out the current before danger from fire could arise. The lamps used would be incandescent lamps, and would be provided with a switch, by means of which the light could be turned on or off at pleasure. If any lamp failed it would not disturb the light in the other lamps. One of the firms—Messrs. Crompton and Co.—have estimated for providing new electroliers and fittings throughout, but the others have estimated for combining the electric lighting to the present gas fittings. This would be done without interfering with the use of the gasaliers for gas lighting.

"If the electric current is taken from the local companies it would be passed through an accumulator, and will be at command like gas. A meter for measuring the current will be fixed, and the Vestry will pay for what is used. The description given as to the cables and lamps, &c., would apply to this method.

"The prices for which a separate installation is offered vary from £1,935 to £800; but these figures afford no guide whatever to the determination of which of the tenders is the most desirable. A study of them resolves itself into a question of what is not included in the sum. Some include accumulators; some fittings and electroliers; while some exclude wiring, builders' and decorators' work, foundations for engines, &c. Quality of work and workmanship have, no doubt, something to do with the difference of price. In the comparative list given hereafter I have added to each of the tenders a sum equal to that which would have to be spent to complete the installation and the work, so as to reduce—or rather, enlarge—them to something like a standard.

"The amount of light asked for is somewhat in excess of that usually provided. Some of the firms have pointed this out, but have estimated for the quantity specified, while others have reduced the quantity to that they deem necessary. Hence the tenders vary from 306 to 234 lamps of 16 candle-power. I have in every case added a sum to the tenders of those who have lessened the light to allow of the light reaching that specified, in order to facilitate a comparison.

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"The firms have each supplied an estimate of the annual cost of running the light for 1,000 hours a year, and maintaining it. These estimates vary from £558 to £246. The sums stated are not comparable, and afford no hint as to the most economical installation. One firm includes £182 a year for labour and superintendence, while another does not include any sum for these items, although they call attention to the fact that something will have to be added for them; one firm puts the lamp renewals at £90, while another allows £10; one firm estimates the life of the lamps at 2,000 hours, while another says 1,000 hours; one firm puts coal at 20s. per ton, while another puts it at 16s. per ton; one firm allows £150 for depreciation, while another allows £36.

"It is impossible to reconcile these differences; they are as amusing as they are perplexing. I have, therefore, as a rough means of arriving at a comparative statement, reduced them to a standard. In each case I have allowed £78 for labour; 1,000 hours as the life of the lamps, and 300 as the number necessary, or a sum of £63. 15s., which equals their value; coal has been calculated at 20s. per ton; oil, waste, &c., have been put at £20; depreciation has been calculated on the total sum, including such added sums as are necessary to complete the installations, at the rate of 7½ per cent.; while interest on the capital has been calculated at 4 per cent. The estimates, after being crushed into this mould, are scarcely recognisable; but the result affords a safer guide than the estimates themselves.

"In all the estimates the lighting has been taken at 1,000 hours per year, so as to have a common basis. The present gas bill for this time would be £180. The cost of gas is 2s. 5d. per 1,000 cubic feet. One thousand feet of gas give 3,200 candle-power per hour, or a cost of ·145d. per 16 candle-power per hour. An addition to this sum must be made for gas burners, globes, &c., making the net cost equal to ·15d. per 16 candle-power per hour, or about one-seventh of a penny. These figures do not include any charge for capital or depreciation of the gas fittings, as these are necessary in any case. In the present stage of electric lighting it would not be desirable to do without the means of lighting by gas.

"At the same time it is well to point out that a sum of £726 is sunk in the gas pipes and fittings. This, at 4 per cent. interest, equals £29. 1s. per year, and, allowing £20 a year for depreciation, it equals a charge of £49. 1s. per year. Working this out at 1,000 hours a year it equals a charge of ·04d. per hour per 16 candle-power, which, when added to the ·15d. per hour, makes the total cost of gas equal to ·19d. per 16 candle-power per hour. This latter sum does not represent the cost saved by using the electric light, for the capital in the gas pipes and fittings would not be recovered in the change. It represents the cost of gas for comparison with electric light if the Town Hall had neither gas fittings nor electric light fittings, and the Vestry was bold enough to do without gas. The cost for comparison is ·15d. per 16 candle-power per hour.

"The following is a table of the annual costs of the systems tendered for when the estimates have been standardised:—

	Annual Cost. £	s.	d.		Cost of 16 candle-power per hour. d.
The Chelsea Electricity Supply Co....	583	7	0	...	·467
The Cadogan Electric Light Co.	536	8	4	...	·429
Messrs. Drake and Gorham	516	5	6	...	·413
Messrs. Siemens Bros. and Co........	502	7	0	...	·402
Messrs. Edison, Swan and Co.........	483	11	9	...	·395
Messrs. Crompton and Co.	462	4	0	...	·369
Mr. Ronald Scott	453	15	0	...	·363
Messrs. Smith and Co.	450	13	0	...	·361
The Anglo-American Brush Co.	444	5	0	...	·355
Messrs. Holmes and Co.	440	14	0	...	·353

"It may be taken that the cost by a separate installation will be from 2⅓ times to 2⅔ times the cost of gas, and the cost from a central station will be three times that of gas.

"The following were the estimates sent in by the selected firms:—

"CHELSEA ELECTRIC COMPANY.

"This company proposes to supply the current from a central station, and to charge for the electricity by meter. Their estimate for providing conductors, wires, casings, switches, cut-outs, eight circuits, 291 16 candle-power incandescent lamps, and plain electric fittings, is £507. 10s. They propose to supply the current at 8d. per Board of Trade unit, which is between ½d. to ⅓d. per 16 candle-power per hour. The company has not a central station yet. They estimate the annual cost, allowing 1,000 hours for the life of the lamps, at £543. 4s. This estimate standardised is:—

	£	s.	d.
Lamps and current	£543	4	0
Interest on £507 at 4 per cent.	20	3	0
Depreciation on fittings	20	0	0
	£583	7	0

Or ·467d. per 16 candle-power per hour.

"CADOGAN ELECTRIC COMPANY.

"This company proposes to supply the current from a central station, and to charge for the electricity by meter. Their estimate for providing conductors, wires, switches, cut-outs, six circuits, 235 16 candle-power lamps, adapting the gaseliers to the electric fittings, &c., is £566. 19s. They would provide and keep in order at their own cost an accumulator to hold current for six or seven hours. The charge for the current will not exceed 7d. per Board of Trade unit, which they say is as near as possible ⅓d. per 16 candle-power per hour. (According to the usual means of calculating the cost the price would have to be less than 7d. per unit to reduce the cost to ⅓d. of a penny per 16 candle-power lamp per hour.) The annual cost would be:—

	£	s.	d.	£	s.	d.
300 lamps for 1,000 hours each, at ⅓d. per lamp per hour..				£426	13	4
Depreciation				20	0	0
Interest at 4 per cent. on	£566	19	0			
Add to make up to 300 lamps	83	1	0			
	£650	0	0	26	0	0
Lamp renewals........................				63	15	0
				£536	8	4

Or ·429d. per 16 candle-power per hour.

"DRAKE AND GORHAM.

"This firm proposes to provide a duplicate plant without accumulators. Their estimate for two 12 horse-power Marshall engines with boilers, two Worthington pumps, two Elwell-Parker dynamos, two driving belts, 306 16 candle-power lamps, switch-boards, switches, cut-outs, wires, &c., is £1,935. 9s. The estimate does not include builders' work, structural alterations, or ornamental fittings. Their estimate of the annual cost is:—

	£	s.	d.
Coal, 86 tons at 16s..	£68	16	0
Water, oil, waste, &c.	19	0	0
Depreciation	75	0	0
Lamps (life, 1,500 hours).....................................	40	0	0
Interest (4 per cent. on £2,000)........................	80	0	0
Labour, £2 per week..	104	0	0
	£386	16	0

"The estimate standardised is:—

	£		£	s.	d.
Coal, 86 tons at 20s..			£86	0	0
Oil			20	0	0
Labour			78	0	0
Lamp renewals			63	15	0
Depreciation on......................	£1,935				
Add for omitted works............	400				
	£2,333	at 7½ p. c....	175	2	6
Interest on ditto at 4 per cent..........................			93	8	0
			£516	5	6

Or ·413d. per 16 candle-power per hour.

"SIEMENS BROTHERS AND CO.

"This firm proposes to generate the current by steam power. Their estimate for a boiler, direct-driving steam engine, Siemens dynamo, 106 16 candle-power lamps, and 256 8 candle-power lamps, adapting fittings, wires, six circuits, switches, &c., is £1,640. They do not include an accumulator, builders' work, an engine-house, &c., in the estimate. Their estimate of the annual cost is:—

	£	s.	d.
Coal, 60 tons at 20s.	£60	0	0
Oil, waste, &c..	12	0	0
Interest, 4 per cent.	65	12	0
Depreciation, 10 per cent. on £800	80	0	0
Do. 5 per cent. on £750	37	10	0
One set of lamps, £90	90	0	0
Repairs, 2½ per cent. on £800	20	0	0
	£365	2	0

"Their estimate standardised is:—

	£		£	s.	d.
Coal, 60 tons at 20s.			£60	0	0
Oil...			20	0	0
Labour			78	0	0
Lamp renewals			63	15	0
Depreciation on	£1,640				
Add for omitted works, &c.	800				
	£2,440	at 7½ p.c.	183	0	0
Interest on do. at 4 per cent.			97	12	0
			£502	7	0

Or ·402d. per 16 candle-power per hour.

"EDISON AND SWAN COMPANY.

"This company proposes to generate the current by gas power. Their estimate for a 14 horse-power 'Otto' gas engine, a 220 light Edison-Hopkinson dynamo, an accumulator, 263 16 candle-power lamps, wires, switches, cut-outs, &c., is £1,220. It does not include fixtures, structural alterations, gas or water supply. Their estimate of the annual cost is:—

	£	s.	d.
Attendance	£78	0	0
Gas, at 2s. 10d. per 1,000ft.	144	8	0
Oil, waste, &c...	44	0	0
Lamp renewals	42	10	0
Upkeep of accumulators	41	10	0
Upkeep of engine, &c.	18	0	0
Interest, 4 per cent. on £1,220	48	16	0
	£417	4	0

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"This estimate standardised is :—

Gas, at 2s. 5d. per 1,000ft.		£124	0	0
Oil, &c.		20	0	0
Labour		78	0	0
Lamp renewals		63	15	0
Depreciation on	£1,220			
Add for omitted works, &c.	500			
	£1,720 at 7½ p.c.	129	0	0
Interest on do. at 4 per cent.		68	16	0
		£483	11	0

Or ·395d. per 16 candle-power per hour.

"CROMPTON AND CO.

"This firm proposes to generate its current by steam power. Their estimate for a multitubular boiler, Willans engine, Crompton dynamo, 260 16 candle-power lamps, cut-outs, wires, switches, indicator, new fittings, &c., is £1,541. 17s. 6d. It does not include an accumulator. Their estimate of the annual cost is :—

Coal, 50 tons at 17s. 6d.		£43	15	0
Lamp renewals (life 2,000 hours)		32	10	0
Oil, waste, &c.		20	0	0
Labour (half time man and boy)		58	10	0
Depreciation, 7½ per cent. on £1,180		88	10	0
Interest at 4 per cent on £1,541		61	13	6
		£304	18	6

"This estimate standardised is :—

Coal, 50 tons at 20s.		£50	0	0
Oil, waste, &c.		20	0	0
Labour		78	0	0
Lamp renewals		63	15	0
Depreciation on	£1,541			
Add for omitted works, &c.	637			
	£2,178 at 7½ p.c.	163	7	0
Interest on do. at 4 per cent.		87	2	0
		£462	4	0

Or ·369d. per 16 candle-power per hour.

"THE BRUSH COMPANY.

"The firm proposes to use steam power. Their estimate for a 20 horse-power boiler, Brush engine, dynamo, 266 17 candle-power lamps, cut-out, meters, switch-boards, switches, belt, &c., is £800. It does not include wiring, fittings, builders' work, or accumulators. Their estimate of the annual cost is :—

Coal, 64 tons at 20s.		£64	0	0
Water, oil, &c.		15	16	0
Lamp renewals (life, 1,000 hours)		59	16	0
Labour		78	0	0
Interest, 4 per cent. on £800		32	0	0
Depreciation, 7½ per cent. on £800		60	0	0
		£309	12	0

"This estimate standardised is :—

Coal		£64	0	0
Oil, waste, &c.		20	0	0
Labour		78	0	0
Lamp renewals		63	15	0
Depreciation on	£800			
Add for omitted works, &c.	1,100			
	£1,900 at 7½ p.c.	142	10	0
Interest on do. 4 per cent.		76	0	0
		£444	5	0

Or ·355d. per 16 candle-power per hour.

"GEORGE SMITH AND CO.

"This firm proposes to use gas power for their current. Their estimate for a gas engine, two dynamos, storage batteries, 247 16 candle power lamps, wires, castings, &c., complete, is £1,330. It does not include laying gas on to the engine. They call attention to the fact that an attendant will be required. Their estimate of the annual cost is :—

Lamp renewals		£50	0	0
Oil, waste, &c.		8	0	0
Depreciation		54	0	0
Gas		80	0	0
Interest		54	0	0
		£246	0	0

"This estimate standardised is :—

Gas		£110	0	0
Oil, waste, &c.		20	0	0
Labour		78	0	0
Lamp renewals		63	15	0
Depreciation on	£1,333			
Add for extra lights	223			
	£1,556 at 7½ p.c.	116	14	0
Interest at 4 per cent.		62	4	0
Or ·361d. per 16 candle-power per hour.		£450	13	0

"MR. RONALD A. SCOTT.

"This firm proposes to generate its current by steam power. Their estimate for a multitubular boiler, Willans engine, dynamo, switch-board and switches, meters, 200 lamps, fittings, cut-outs, &c., is £1,580. It does not include accumulators. The estimate of the annual cost is :—

Stoker and engine driver		£78	0	0
Electrician		104	0	0
Lamps replaced		10	0	0
Oil and waste, &c.		29	0	0
Fuel		62	0	0
Engine repairs		20	0	0
Storage batteries replaced		25	0	0
Interest		80	0	0
Depreciation, 10 per cent. on £1,500		150	0	0
		£558	0	0

"This estimate standardised is :—

Coal		£62	0	0
Oil, waste, &c.		20	0	0
Labour		78	0	0
Lamp renewals		63	15	0
Depreciation on	£1,580			
Add for omitted works	420			
	£2,000 at 7½ p.c.	150	0	0
Interest at 4 per cent.		80	0	0
		£453	15	0

Or ·363d. per 16 candle-power per hour.

"HOLMES AND CO.

"This firm proposes to use steam power. Their estimate for a 16 horse-power multitubular boiler and chimney, Worthington pump, Willans engine, No. 14 Castle dynamo, 300 16 candle-power lamps, cut-outs, wires, voltmeter, &c., is £930. It does not include wiring the Town Hall, foundations to boiler and engines, fittings, access for machinery, or accumulators. Their estimate of the annual cost is :—

Coal, 57 tons at 16s.		£45	12	0
Lamps (life 2,000 hours)		30	0	0
Oil and waste		10	0	0
Sundry repairs		20	0	0
Interest and depreciation, 8 per cent.		72	0	0
Labour, man at 28s.		72	16	0
		£250	8	0

"This estimate standardised is :—

Coal, 57 tons at 20s.		£57	0	0
Oil		20	0	0
Labour		78	0	0
Lamp renewals		63	15	0
Depreciation on	£930			
Add for omitted works, &c.	1,000			
	£1,930 at 7½ p.c.	144	15	0
Interest at 4 per cent.		77	4	0
		£440	14	0

Or ·353d. per 16 candle-power per hour.

PETITION IN FAVOUR OF LORD THURLOW'S ELECTRIC LIGHTING BILL.

At a recent meeting of the Electrical trade held at the offices of the Anglo-American Brush Electric Light Corporation (Limited) it was decided to petition in favour of Lord Thurlow's Bill now before the House of Lords to amend the Electric Lighting Act of 1882, and the following petition has been extensively signed by the principal electrical companies and firms and by gentlemen representing the scientific interests of the industry :—

"IN THE HOUSE OF LORDS,
"SESSION, 1888.

"ELECTRIC LIGHTING ACT (1882) AMENDMENT BILL.

"PETITION IN FAVOUR OF THE BILL.

"*To the Right Honourable the Lords Spiritual and Temporal in Parliament assembled :—*

"The most humble petition of the companies and persons being traders and persons interested commercially and scientifically in the subject of electric lighting in the United Kingdom whose seals and names are hereunto attached and subscribed.

"1. A Bill is now pending in your Lordships' House, intituled 'An Act to amend the Electric Lighting Act, 1882,' and having for its especial purpose the extension from 21 to 42 years of the period limited by the aforesaid Act of 1882, after the expiration of which local authorities may

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have an option of purchasing electric lighting undertakings within their district, and being in respect of the aforesaid extension of time based upon the report from the Select Committee of your Lordships' House on various Electric Lighting Bills in the year 1886.

"2. Your petitioners claim to represent the commercial and scientific interests of the United Kingdom on the subject of electric lighting, and are of opinion that the proposed extension of the aforesaid period and other amendments of the existing law proposed by the said Bill will so far lessen the restrictions which have hitherto prevented the industry from developing as to enable at least some progress to be made in its development.

"3. Another Bill has been introduced into and is now pending in your Lordships' House, intituled 'An Act to Amend the Electric Lighting Act, 1882,' and bearing the short title of 'Electric Lighting Act, 1882, Amendment (No. 2) Bill,' the object of which is to effect far-reaching changes in the existing law, which, while they might very possibly attain the object in view, raise weighty and complex questions connected with the powers of local authorities; and your petitioners are very apprehensive that the discussion of these questions must necessarily lead to further delay in affording relief of which the public desirous of having the advantage of electric lighting and the electric lighting industry is so urgently in need. Your petitioners therefore respectfully submit that the Electric Lighting Act, 1882, Amendment Bill firstly hereinbefore referred to, which is based as aforesaid upon an exhaustive inquiry which has already been held, ought not to be delayed pending any inquiry which may be considered necessary into the proposals contained in the Electric Lighting Act, 1882, Amendment (No. 2) Bill, and that if the proceeding with the last-named Bill would have this effect it should not be proceeded with.

"Your petitioners therefore most humbly pray your Lordships that the Electric Lighting Act, 1882, Amendment Bill, may be allowed to pass into a law in the course of the present Session, and that the Electric Lighting Act, 1882, Amendment (No. 2) Bill, may not so far as its proceeding will delay the passing into law of the previous Bill be allowed to proceed.

"And your Petitioners will ever pray."

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April 7th*, 1888.

In my last letter I made reference to the troubles which had arisen between Mr. Gould and certain of his opponents, Mr. Gould claiming that certain lawyers were trying to blackmail him in connection with railroad matters, and that among their allies were the *New York Herald* and the Commercial Cable Company. This gentle accusation was, of course, denied, but it was followed up on Sunday last by an open letter published in nearly all the newspapers, including the *Herald*, from Mr. Gould to Mr. Bennett. This letter has caused an immense sensation. In it Mr. Gould traces Mr. Bennett's bitterness and opposition to him back to some early negotiations connected with the American Cable Company and the American Telegraph Company. Mr. Gould alleges that the *Herald* then demanded lower rates than were paid by other newspapers, and a precedence over them in the transmission of news. "In other words, you were attempting to use the corporation of which you were a trustee not only for your personal profit and advantage, but to the injury of your rivals. I stated, further, that your attempts were so persistent and so offensive that at the first opportunity your name was dropped from the Board." In support of this statement, Mr. Gould prints a memorandum made at the time by one of the directors, which further alleged that the bitterness of the *Herald* had been intensified since the refusal of the "cable pool" to allow the French Company to renew its contract with the *Herald*, at special rates, at about half the price the other papers were being charged; the failure of this effort leading to the establishment of the Commercial Cable system. At this point of the letter Mr. Gould waxes warm, and apparently losing self-possession, pitches into Mr. Bennett with some of the most extraordinary personalities that ever found their way into New York journals, which are not noted for squeamishness in this respect. Mr. Gould, in fact, tells some piquant stories about Mr. Bennett's debaucheries and sprees, and winds up with a horrible yarn about Mr. Bennett landing some yachting guests at the Morgue, and himself tumbling into one of the coffins there. I need go no further to indicate the nature of the letter, having said enough to show why all New York, and for that matter all the United States, is talking about it. These personalities certainly "have nothing to do with the case," whether it be the railroad litigation or the cable war, but their presence is taken as an indication in electrical circles that we are not likely soon to see the cable compromise which was so confidently expected not long since.

Now that the great telephone litigation is practically settled, some of the newspapers are promising us a big lawsuit between Mr. Edison and Mr. Bell regarding priority of invention in the phonograph and graphophone field, it being alleged that while Mr. Edison has brought out the phonograph, Prof. Bell was the first to give it its practical shape. The New York *Sun* published a few days ago quite a long article, in which it stated, with all circumstantiality, that the suit in question was, however, to be only collusive, that the graphophone and phongraph interests would join hands, and that simply one type of machine would be presented to the public for patronage. This story hardly coheres with some of the facts of the case, for it is well known that both phonographs and graphophones are being made to-day, and if there is to be any sort of immediate understanding, one machine or the other would be dropped. The article in question states that it is the intention to build a thousand of the graphophones, and that three hundred have already been made. These instruments are to be handled on telephonic business principles—that is, they are not to be sold outright—but to be leased, and the rate is to be not less than $60 dollars each per annum. The machines are said to be in good shape, and to be easy to manipulate. The instrument complete is somewhat smaller than the ordinary typewriter, and the ordinary wax tube which takes the impression is about seven or eight inches long, and an inch in diameter, having a capacity for about 250 words. Those who are handling the invention say that it will supersede stenography, which is very much doubted by the stenographers.

Another ingenious device of quite a different character is that which has just been put upon the market by a company manufacturing under the patents of Mr. P. B. Delany, whose synchronous multiplex telegraph system has been adopted by the English telegraph department. This device is intended as a protection for linemen and others against electric shock. It consists of a pair of broad linked bracelets, which encircle the wrists, and another pair which, like garters, clasp the leg just above or below the knee. These are connected in such a way that the wearer may be said to have a flexible lightning rod down his back. The claim is made that by this electrical *bijouterie* large enough portions of dangerous currents can be shunted to save life, the portion of shunted current depending, of course, on the moistness of the skin and the closeness of contact between the bracelets and the arms and legs of the wearer. It is proposed, I believe, that the connections shall be concealed under the coat of the lineman, who otherwise would probably be the object of very marked attentions as he proceeded to answer duty's call along the busy thoroughfares of the city. Experts who have seen it consider that the device has no small merit, and think that the only trouble would be in getting the average lineman to deck himself out in this glittering splendour and shawl strap paraphernalia.

I learn Professor Forbes leaves here to-day, and his present visit to the United States has been most agreeably, and I trust, profitably spent. There is a report current, by the way, that he has made an advantageous disposition of his meter, or the patents thereof, for this country.

An important hearing has been had this week before Judge Wallace in the United States Circuit Court for this district in the equity suit of the Edison Electric Light Company against the United States Electric Light Company. This suit dates back to the beginning of 1885, and affects six of Mr. Edison's leading electric light patents. The decision that is asked for from the Court does not touch the direct and main issues, but is relative to the effect which the limitation and expiration of foreign patents has upon the United States patents. As you are doubtless aware, it has already been decided in one or two cases that, under Section 4,887 of the United States Revised Statutes, the term of a United States patent is limited by the shortest term of any corresponding patent which had "previously" been taken out in a foreign country. It is contended,

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however, that the section referred to has never been properly and thoroughly interpreted, and that its muddy and confused language must not be construed in any way to injure the American inventor in his own country, or those who may hold from him. In the present case it is argued that there is no evidence to show that the foreign patents—Italian, Austrian, &c.—or the original terms thereof, have expired. The question is raised whether the section, after all, has any application at all to the American inventor or patentee whose invention was made and reduced to practice in the United States, and who has in every respect complied with the law; and, next, whether an opportunity should be afforded to any inventor, who has assigned his invention, to deliberately defraud anybody, as he might, by getting a foreign patent in such a way as to invalidate rights which he had already sold, leaving the field open for new rights and a new sale on some modification of the thing invented. I could go into the matter in more detail, but have said enough to indicate the importance of the subject. There is a very general feeling that this principle of limiting the term of American patents so arbitrarily, even if it be found embodied in the present law, is a very bad and harmful one, and that, if necessary, the law should be changed. In order to avoid the uncertainty which thus, under existing conditions, cloud patents taken out abroad as well as at home, in this particular respect, American attorneys and patentees are put to very great trouble, inconvenience, and embarrassment—the counter good to which nobody can perceive. This big question has never been adjudicated upon by the United States Supreme Court, but will probably reach it upon appeal in the present instance, whichever way the decision goes in the lower court. It will undoubtedly be a great relief to have the points settled definitely and finally, though, if the settlement be left to the Courts, and no change be made in the law, should it require it, we must wait at least three or four years.

There is no little activity at present in electrical literary circles. You have already noted from time to time the extension of the field of electrical journalism in the United States, and may now add the announcement that another electrical publishing company has been formed in Chicago. In regard to books, I may mention the appearance of a very handy little book giving instructions to dynamo tenders, in the construction, maintenance and operation of electric light and power plants. It is publised by the *Western Electrician* Company, of Chicago. The author is Mr. F. B. Badt, who was at one time, I believe, an officer in the Prussian army, and is now connected with electric lighting in Chicago. Another book, which is in fact of the first importance in many respects, is that by Carl Hering, on "The Principles of Dynamo Electric Machines." It is the first book of the kind published in America, if we except such works as that of Prescott, and the translation made by Keith, of Schellen. It deals with the designing and construction of dynamos, and contains an appendix of no mean size, embracing articles on several allied topics. The book is published by Mr. J. Johnston, and will, I suppose, reach you in due time for review. I hear that a large sale is expected for it in this country. This month has seen also the appearance of no fewer than three electrical articles in the leading magazines. In the *Century*, Mr. Frank L. Pope has a very interesting illustrated article on "The American Inventors of the Telegraph," with special reference to the work and services of Alfred Vail. In the *North American Review* Mr. T. C. Martin has a picturesque article on "Gilbert's Tables," in which, dating from the first exhibition of the Morse telegraph in New York, in 1838, he traces, with striking details and statistics, the practical development of electricity in this country. A third article on "The Dawn of Electricity," by Dr. Park Benjamin, appears in the *Forum*, in which the writer gives a remarkably able and vivid sketch of the career and work of Dr. Gilbert. This article strikes one as having been a labour of love with Dr. Benjamin, for it is a masterly rehabilitation of the character and achievements of the old English worthy. It is said that the author has made some very exhaustive studies in early electrical literature, and if the present article be a sample of the results it is to be hoped that he will soon give us some more of them.

MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-NIGHT) FRIDAY, April 20th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. "The Speed Trials of the latest addition to 'The Admiral' Class of British War Vessels." By Mr. DAVID S. CAPPER, M.A., Stud. Inst. C.E.

ROYAL INSTITUTION.

9 p m. Lecture, "Antagonism." By the Right Hon. Sir WM. R. GROVE, M.A., LL.D., F.R.S., M.R.I.

SATURDAY, April 21st.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Later Works of Richard Wagner" (2). By Mr. C. AMBRUSTER.

MONDAY, April 23rd.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture V. "Milk Supply and Butter and Cheese-Making" (3). By Mr. RICHARD BANNISTER.

INVENTORS' INSTITUTE.

8 p.m. Ordinary Meeting.

TUESDAY, April 24th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read, with a view to discussion, "The Distribution of Hydraulic Power in London." By Mr. E. B. ELLINGTON, M.I.C.E.

SOCIETY OF ARTS.

8 p.m. Applied Art Section. "Craftsman and Manufacturer." By Mr. LEWIS FORMAN DAY. Mr. J. SPARKES, Principal of the National Art Training School, will preside.

ROYAL INSTITUTION.

3 p.m. Lecture, "John Ruskin" (3). By Dr. C. WALDSTEIN.

ROYAL VICTORIA HALL (Waterloo Bridge-road, S.E.).

8 p.m. "Soap Making." By Mr. W. P. BLOXAM.

WEDNESDAY, April 25th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Physical Culture of Women." By Miss CHREIMAN. Dr. RICHARDSON, M.A., F.R.S., will preside.

CITY AND GUILDS OF LONDON INSTITUTE (Central Institution), Exhibition-road, S.W.

7:30 p.m. Meeting of Old Students' Association. Paper on "Solution." By Mr. H. CROMPTON.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. Paper on "Railways for Rural and Undeveloped Districts." By Mr. J. B. WALTON, M.I.C.E.

THURSDAY, April 26th.

SOCIETY OF TELEGRAPH-ENGINEERS.

8 p.m. Extraordinary General Meeting at the Institution of Civil Engineers. "On the Risks of Fire Incidental to Electric Lighting." By Mr. W. H. PREECE, F.R.S., Past President.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Chemical Arts" (3). By Prof. DEWAR.

FRIDAY, April 27th.

ROYAL INSTITUTION.

9 p.m. "Electrical Influence Machines." By Mr. JAMES WIMSHURST, M.R.I.

SATURDAY, April 28th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Later Works of Richard Wagner" (3). By Mr. C. AMBRUSTER.

PHYSICAL SOCIETY OF GLASGOW UNIVERSITY.

Paper on "Theory of Gases." By Mr. W. COLQUHOUN, M.A.

PHYSICAL SOCIETY (LONDON).

3 p.m. "On Electromotive Force by Contact." By Mr. C. V. BURTON. "A Theory Concerning the Sudden Loss of Magnetic Properties of Iron and Nickel." By Mr. H. TOMLINSON. Note on "The Graphic Treatment of the Lamont-Frölich Formula for Induced Magnetism;" Note on "The Conditions of Self-Excitement in a Dynamo Machine;" and Note on "The Conditions of Self-Regulation in a Constant Potential Dynamo Machine." By Prof. S. P. THOMPSON.

ANSWER TO CORRESPONDENT.

A. W. PARROTT.—*Thanks.*

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The Electrician.

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THE DIRECTORY FOR 1888 IS NOW READY.

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LORD CRAWFORD'S BILL.

The Electric Lighting Act (1882) Amendment (No. 2) Bill, which has been brought into the House of Lords by the Earl of CRAWFORD, and was read a second time on Tuesday last, introduces several provisions of a novel and important character; and although in the main we fully agree with the views expressed by Lord THURLOW, that the Bill is altogether too complex and crowded with detail to stand a chance of becoming law at an early date, yet there are several points in Lord CRAWFORD's measure which will repay careful consideration. One of the greatest difficulties encountered under the present Act, and one which Lord THURLOW's Bill does nothing to remedy, lies in the fact that not only is the cost of a Provisional Order, and of the Parliamentary procedure consequent thereon, very considerable indeed, but moreover this course of action can only be taken during a certain limited portion of the year, so that a project in every way commendable may have to be held over for six or nine months before Parliamentary powers can be obtained. Lord CRAWFORD proposes to remedy this by providing an additional method of procedure, under which the local authority would have power to enter into an agreement with and to grant permission to the undertakers to carry out their works without obtaining confirmation from the Board of Trade. But, as was pointed out by the Earl of ONSLOW, electric lighting companies are in this respect no worse off than gas, tramway, or railway companies, who labour under precisely the same disadvantages; and it would be difficult to introduce an entirely new principle affecting the relations of local authorities with public companies on the one hand and with the Board of Trade on the other hand, unless they were prepared to make this principle of entirely general application. We fear that this objection is an unanswerable one.

Clause 3 of Lord CRAWFORD's Bill contains a proposal of a decidedly startling character. It stipulates that the right of supply shall be subject to the observance of certain installation rules which are to be laid down by the Board of Trade. It is, perhaps, a little singular that after explaining this clause Lord CRAWFORD immediately made reference to the rules issued by the Phœnix Fire Insurance Company, stating that he was informed that no extra premium was charged on buildings containing installations put up in accordance with these rules, the inference apparently being that the Board of Trade should adopt and enforce the rules of the Phœnix Fire Office. This would at least tend to afford

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a solution of the existing deadlock in connection with Fire Office rules. Upon the whole, however, we fear that such a solution would give rise to very considerable jealousy and heartburnings, though we need scarcely regard it at present as coming within the realm of practical politics. A succeeding clause deals with the question of telephones, and is intended, we are informed, "to protect them from all possible damage by an electric lighting undertaking." We should like to have the exact terms of this clause before us before expressing a decided opinion upon its merits. We are not altogether satisfied that the Telephone Companies ought to be allowed to have things entirely their own way, and this for two reasons. In the first place, a divergence may be effected in a telephone line at a very small fraction of the cost which would be required to effect a similar divergence on an electric lighting circuit. In the second place it is well to remember that the Telephone Companies have always the power to protect themselves against all external inductive interferences simply by the adoption of the complete metallic circuit.

It is further provided that within five years from the passing of the Act all cables or mains shall be placed underground. This is one of those stipulations of which the full signification and bearing can at present only be surmised. The Bill, however, contains no provision for the infliction of a penalty upon any company which might fail to carry out this requirement. Lord CRAWFORD also proposes that "when the undertakers are not a local authority, but a company or private individuals, they shall contribute a certain sum per annum to the relief of the rates for the privilege of being allowed to use the streets." He also intimated that a rate of about £20 a mile would probably be considered fair, and that if the Bill got into Committee he should then be prepared "to state the amount which that rate would realise if London were properly dealt with," adding the somewhat cynical observation that "their Lordships would be surprised to learn to what an extent the rates of London would be relieved if this were done." We fear that this remark will tend to damp any dormant enthusiasm on the part of electric light promoters in favour of Lord CRAWFORD'S Bill. The cost of placing mains underground is already so enormous that even the prospect of being enabled to effect an extensive reduction of the rates will scarcely reconcile the promoters to the proposed additional tax. In concluding his speech, Lord CRAWFORD stated that he knew of his own knowledge that "if the law were made somewhat on the lines of this Bill, within six or eight months large sums of money would be thrown into the country and employment provided for a great number of working men." He believed that under these conditions at least 40,000 men would speedily be employed in preparing these works and upon the business of electric lighting. Although we are scarcely able to share the roseate anticipations of the noble lord quite to this extent, we have yet no doubt whatever that the passage either of Lord THURLOW'S Bill in its present shape, or of Lord CRAWFORD'S Bill with such excisions and amendments as we have hinted at, would give an enormous impetus to the electric lighting industries of this country.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The report of the Directors states that the total earnings for the year ended 31st December, 1887, amount to £159,789. 11s. 1d., an increase of £21,123. 10s. 3d., compared with the twelve months to 31st December, 1886, and that the working expenses for the year, exclusive of renewals of cable, amount to £64,315. 19s. 5d., as against £62,604. 0s. 1d., an increase of £1,711. 19s. 4d. The Directors recommend the payment of a dividend of 3 per cent., free of income-tax, making, with the interim dividend of 1¼ per cent. paid on 15th Oct., a total of 4¼ per cent., carrying forward £3,464. 8s, 7d.

EDISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

This action for the infringement of the patent of Edison's (No. 4,576, of 1879) incandescent lamp, and Cheesborough's patent 4,847 (of 1878), for a mode of making uniform the carbon thread which forms the light-giving portion of the lamp, came on before Mr. Justice Kay on Tuesday last.

The Attorney-General (Sir R. Webster, Q.C., M.P.), Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. Bremmer appeared for the plaintiffs; Sir Horace Davey, Q.C., Mr. Finlay, Q.C., M.P., and Mr. J. C. Graham for the defendants, who are Mr. Wm. Holland, of the Albert Palace, the Jablochkoff Company, the General Electricity Company, and the Anglo-American Brush Company.

The ATTORNEY-GENERAL, in opening the case, described the patents in question, and claimed that Edison had solved a problem which for forty years electricians had striven to elucidate. In consequence of his invention electric lighting at once leapt from the laboratory to practical commercial use, and these courts would always be a constant record of that fact. If Mr. Street and Mr. Barry had been originally asked whether they had provided for electricity at the time of commencing the courts they would have said that electric lighting was about as far off as it possibly could be.

Sir FREDERICK BRAMWELL, F.R.S., in reply to Mr. ASTON, Q.C., said he had given particular attention to the construction and use of lamps employed in electric lighting very nearly since the introduction of the incandescent method of lighting. He was one of the original shareholders in the Edison Company, and was one now. From time to time during the last ten or twenty years, when various improvements had been made, these lamps had come under his notice. Besides having a professional experience of these matters, he had taken a great practical interest in them. During one of his visits to America in the very early days of electric lighting, he saw what he believed was the first station for distributing light from a central point; and he then also saw the manufacture of the lights. He had made himself acquainted with Edison's patent of the 10th November, 1879, which was the subject of this action. Asked what was the state of public knowledge as regards incandescent lamps at the date of the patent, witness said the very earliest attempt at their construction was by King in 1845. King proposed two modes of making an incandescent lamp—one by means of a platinum strip, which was to be made incandescent in ordinary atmosphere, and the other by means of a piece of carbon made by a saw or file and enclosed within a Torricellian vacuum. There was an enlarged chamber, as it were, at the head of a barometer, which was big enough to contain this portion, and the whole thing was about 30 inches in length. The chamber was made of glass, and he had no doubt the shank was on glass, but the closure at one end of the chamber was mercury. Leaving out of consideration the arc lighting, in 1852 a gentleman of the name of Roberts proposed to use a piece of carbon about half an inch by half an inch, and as thin as it could be made, in a lamp exhausted by an air-pump fitted with a metallic sheet, from which proceeded a pipe with a stop-cock to make the connection with the air-pump, the upper part of the lamp being of glass, secured in the same way to a metallic base. In that way there was a chamber entirely of glass, and, as in King's case, the carbon was cut out of a piece of a carbon already existing.

Mr. Justice KAY suggested that it would be for the defendants to deal with the early history of electric inventions, and that the plaintiffs could then call rebutting evidence, but that they need not go into that matter now.

Mr. ASTON then asked witness whether he had read and considered the various specifications, and made himself acquainted with the specification of the patent of the 10th November, 1879.—Witness said that he had, and that he considered the specification of Edison sufficient to enable an incandescent lamp to be made in the manner proposed by Edison.

As far as you know, what do you say as to the knowledge of incandescent lamps described and proposed to be used by Edison at the date of his patent?—So far as I know, it was new.

So far as your own knowledge and experience go, are you able to point to any successful incandescent lamp which was used prior to the date of Edison's patent?—No. I mean no commercially successful lamp.

Asked whether he meant a lamp which would satisfy the wants of the people who used the electric light in the ordinary way, witness said he had a recollection of platinum incandescent lamps being exhibited and giving a fair light, but since the carbon filament lamp he did not know that anybody had attempted to go on the lines of the platinum lamps. The platinum lamps were used with the ordinary atmospere at a temperature below that which would fuse the platinum. He believed that incandescent lamps were now made with carbon filament, with this exception—that there might be lamps of enormous size which were incandescent and also carbon; but then the question would arise whether the thing could be looked on as a filament in the ordinary sense of the word. Lamps of the size used in lighting the courts, the streets, and clubs and hotels were what he would call carbon filament lamps. At the Athenæum the lamps ranged from 8 candle-power up to 32. He had examined some of the lamps which had been stated to be of defendants' manufacture, and some of them had broken up. The result of his examination was that the lamps were in a very vacuous condition before they were broken, and it was established that they were incandescent lamps possessing a resistance when cold varying from 60 ohms, in two cases, up to 195 or 200 ohms. When heated the resistance would be lowered to perhaps some 60 or 50 per cent. of the original. So far as could be judged by the eye the filament was undoubtedly a carbon filament.

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Taking it as a carbon filament which was carbonised after the filament was formed, what do you say with regard to it, bearing in mind the description given in Edison's specification ?—I do not distinguish any difference. I do not conceive any difference.

May we take it that the filament was flashed ?

Mr. Justice KAY: What does that mean ?

Witness: That the filament had been treated by the Cheesborough process.

Mr. FINLAY said that it must not be taken that he admitted that it was flashed.

Mr. ASTON (to witness): What had been done to the filament in order to bring it into the condition in which it was when you examined it ?—I believe that it had been heated by the passage of electric current through it while it was surrounded by some carbonaceous liquid or carbonaceous gas, such as coal gas, the effect of which would be to deposit carbon upon it in the greatest quantity where it was hottest.

The fragments of a lamp which had been broken by the witness in his experiments were then produced, and Sir F. Bramwell said that he could not see any difference between that lamp and the incandescent lamp described in Edison's specification, except in points of very minor detail. He thought the sort of secondary wire spoken of by Edison between the carbon and the wire loops was not there, but the carbon was attached direct to the leading wires. He had no doubt from their appearance that they were platinum. Until some difference was pointed out to him he was able to say that that was a lamp which was an incandescent electric lamp wholly of glass in a highly vacuous condition, containing a carbon filament made, he believed, into that form before carbonisation—a filament, according to his belief, of less than 100th of an inch in diameter—he thought it was 6½ thousandths—a filament which he believed had had deposited upon it carbon from out of a surrounding carbonaceous liquid or gas, pointing to internal heat by electric current. Referring to Cheesborough's specification, counsel asked in what way was carbon produced in gas retorts suitable for the purpose mentioned in the specification. Witness said he had no doubt that it was produced by deposition from the gas in the retort itself. He knew a special instance of it very many years ago, where it was done with an object. In a gasworks it was an accident, as it were, of the manufacture, but some years ago, in order to render the coal gas for a balloon light, the gas was passed through retorts to obtain a deposition of the carbon out of the gas, leaving out the lighter gas. He recollected seeing the apparatus. Asked whether the carbon so deposited was in any way used for electric lighting, he said he thought that King referred to it, and that it had been used, as Cheesborough stated, for arc lighting. Cheesborough also stated that a better kind was made by powdering the material, and there were varieties of specifications for purifying the material. Cheesborough went on in his specifications to say that neither the one nor the other quality of carbon—neither that melted nor the one from the gas retort—was suitable for electric lighting by incandescence. The sub-divisions of the material and the pressure necessary to produce a perfect article were practically unattainable. He could not say that he had ever experimented in that direction, but he certainly would expect, as Cheesborough said, that carbon of the ordinary sort when heated by the electric current would exhibit points and lines of unequal brilliance. Asked why he should expect this to occur in carbon of the ordinary sort, even when it was scraped and shaped, witness said it was because carbon of the required homogeneity would have varying powers of conduction, and there would be parts where the resistance would be greater than at others, and where the resistance was greater the parts would be hotter and would glow with more intensity.

The patentee goes on to say, "It has been found that a pencil of carbon immersed in hydro-carbon gas or liquid, and heated to an extremely high temperature with a voltaic current, is not itself attacked, but decomposes the surrounding matter, the carbon of which enters and fills up its pores to an extent impossible except with matter in a very attenuated state; it deposits a perfectly homogeneous layer, generally of a bright grey colour, on the exterior surface, and as the carbon increases in size more current is required to maintain its temperature, and if the current is increased according to the demand made upon it, there is apparently no limit to the increase in mass of the homogeneous exterior deposit." I agree with that. Carbon pencils may be cut from this deposit, and may be used in the lamps. The witness then went on to say that he had had his attention called to the various specifications which were relied upon by the defendants as anticipating Cheesborough's patent. Counsel was proceeding to examine witness upon the novelty of this patent, but Mr. Justice Kay suggested that that should be left till after the defendants' case, when, if necessary, plaintiffs could call rebutting evidence. Witness, in continuation, said that he considered that Cheesborough's specification was a sufficient one. As regarded the filament of the defendants' lamp, which he had examined, he had reason to believe that it was treated by a process such as Cheesborough pointed out.

As far as you know, is the term "flashing" a term commonly applied to the processes which Cheesborough described ?—Yes.

Cross-examined by Mr. FINLAY, witness said he believed that lamps had been made according to the patent of Mr. Edison now in question for commercial purposes and used commercially apart from any subsequent improvements. He could not, however, say of his own knowledge. Only one improvement occurred to his mind, and that was making the vacuum after a current had been put through. With that exception, as far as he knew, the lamps in the court were what he should call thorough Edison lamps.

Do you say that the lamps in this court are lamps made under this patent of Mr. Edison's now in dispute ?—I should think they undoubtedly were.

I appeal to your knowledge ?—You see that that involves my putting an interpretation upon the patent. According to my judgment they are. You tell me they are not; but still that is my opinion, if the patent be what I think it is. If I am wrong, then they may not be according to the patent.

In all electric lamps that have been made since then have not additional processes been applied, some of them secret processes, necessary for the perfection and efficiency of the lamp ?—Not to my knowledge. I know of secret processes employed in the manufacture of the lamp for the purposes of economy and of securing a better light, but I know of no secret processes which have been employed for the purpose of improvement.

Can you give me of your own knowledge any case of an electric lamp manufactured simply under this patent in dispute ?—With the exception of the final exhaustion I should say every lamp almost, according to my point of view of the patent.

What is your view of this patent ?—That there is disclosed there an incandescent carbon filament lamp, the filament being formed to shape before carbonisation, the lamp being wholly of glass and containing a high vacuum, and the leading wires being fused through the glass.

Is the stress laid upon the filament in the view you take of the patent ?—I am not aware that I lay stress upon any particular part of it. I think the filament a very highly important part, and I should say one without which the lamp would not be commercially successful.

Witness was then examined upon the provisional specification, dated 17th June, 1879 (No. 20,402), which, by the use of platinum or metallic wires, secured "pyro-insulation." His recollection was that there was some protective matter on the surface of the wires. Pyro-insulation meant that the wire was introduced into some such substance as oxide of magnesia.

The word filament is used in the specification, and you have used it more than once. What sense do you attach to the word in your evidence and in the specification ?—I think the best illustration is to take the actual cotton thread of carbon. I do not think it may be called a rod of small sectional area. The word rod hardly implies it to my mind.

Asked whether he would call what was shown on the drawing annexed to the specification a thread, witness said there was no scale attached to it. He had to imagine a scale by assuming that that lamp was some such sized lamp as was now known, and, assuming that, he should say it was a very large thread and a very stout one; indeed, more like packing twine or something of that sort. But he paid no attention to that detail in the drawing, having regard to what was stated in the patent, "a cotton thread."

Mr. Finlay here wanted to cross-examine the witness upon the specification of 15th December, 1879, No. 5127, but the Attorney-General objected that that was a specification of later date, and they could not construe a filament in the specification in question by a later specification.

Mr. FINLAY then asked witness whether in this specification the carbon filament was not a tolerably substantial piece of carbon ?—Witness said he did not know whether any directions were given as to the size of this at all, by reference to the patent under consideration, but there was a case where apparently the term filament was applied to something which had a flat section.

Taking it that the leading idea of this patent was the small sectional area for the purpose of increasing the resistance to the electric current, there was nothing novel in that, was there ?—I think there was not by taking any kind of conductor, but I believe there certainly was by taking the carbon.

Take first the platinum—that idea had been developed by Mr. Lane-Fox ?—Yes, I think so. It is perfectly clear from Mr. Lane-Fox's specification that he was fully aware of the value of high resistance in incandescent lamps.

And producing that high resistances by diminishing the sectional area of the conductor ?—I have no doubt; and by using that which to begin with was as highly resisting a metal as he could probably get.

And also with a small sectional area ?—No doubt. The next patent of Lane-Fox, dated 9th October, 1878, looks something like a pyro-insulation. Lane-Fox there proposed to use a material which was asbestos saturated with carbon, but what that may be I do not know.

Witness was then examined upon Mr. Lane-Fox's patent of 1878, No. 4,626. He said he thought that a most elaborate description was given of the carbon lamp in the provisional specification, but that it was dismissed in the most cursory manner in the final, and that there was no drawing whatever of the lamp suggested. The carbon lamp was a lamp which could be opened, and the light was to be made by the contact of a vertical pencil and the carbon at its upper end against the piece of carbon. It was a sort of semi-arc semi-incandescent lamp. Witness was then taken to the Pulverman provisional specification. He said that related to lighting by the voltaic arc. When the patentee came to incandescent lighting he used a fine platinum wire.

Reference was then made to the provisional specification granted to Lane-Fox in 1879; and witness was asked in what particulars that was not an anticipation of the patent now under discussion.

Witness said that Lane-Fox proposed to make a compound material of carbon and a certain non-conducting material pounded finely and mixed together; but there was no suggestion of carbonisation after the materials were so mixed and the bridge was formed. There was to his mind, both as regards material and the mode of manufacture, an important distinction.

Is your first point that it was not carbon alone ?—It was not carbon alone; it is a mixture of carbon and some con-conducting material mixed as a powder. I should think he would have enormous difficulty in making sure that they were equally proportioned throughout the length of the bridge, and if they were not, he would have more and less luminous parts upon it; but even if he could succeed in mixing them up in absolutely the same proportion throughout the length of the bridge, even then there is no carbonisation after the bridge—that is to say, the glowing part—is formed, as there is in the plaintiffs' patent.

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In the first place it is not carbon alone, but there are two substances mixed as powders; and in the second place the bridge is not carbonised after formation ?—Yes; and I think that is a very important distinction.

In further cross-examination, witness admitted that Mr. Edison in his patent proposed to adopt, not merely simple carbon, but carbon together with a non-conducting, non-carbonisable substance, and that would answer the first of his two points, if that was the only mode in Mr. Edison's patent.

Take the second point, do you put it that the essential point, or an essential point of Edison's patent, is carbonising after the formation of the filament ?—I think so. In Lane-Fox's specification there is a thing I do not understand. Lane-Fox is an extremely able man, but I do not understand his suggestion at the bottom of page 94, No. 1,122, of 1879, where he says:—"In order that the luminous bridge may be as much as possible equal throughout, I make it narrower at and near the ends and in the middle." That does appear to me to be a misdirection.

Is there any other point of difference between this patent and Mr. Edison's ?—It is not clear to my mind that this glass vessel is very fully described. I think, if we did not know a very great deal about it, we should hardly get it from that specification.

In the patent under discussion about six different ways are suggested of making the luminous portion of the lamp. Have you tried to make a filament by the directions given in this patent ?—I have not.

Have you seen the operation of making a filament according to any of the directions given in this patent of Mr. Edison's ?—Yes; I have seen the process of making a thread.

"Properly carbonised and placed in a sealed glass bulb exhausted to one millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current; that if a thread be coiled as a spiral and carbonised," and so forth—Is that the description that you have seen carried into effect ?—Yes.

Then the whole description of the process which you have seen carried out is "cotton thread properly carbonised ?"—In the United States, at Edison's own factory, I have seen them making it direct from the bamboo. As far as I know, that was not under the subsequent patent. The specification here says, "any fibrous vegetable material." I think I saw it made from the bamboo in 1882. It certainly was not before 1882. When I have said that I have seen a filament made out of carbonised thread, I should like to say that that thread was treated, before carbonisation, in a particular way.

How was the thread treated before carbonisation ?—It was treated with sulphuric acid. I do not mind saying that much. But there are certain things done afterwards which, unless his lordship says I ought to say, I would rather not mention.

Was this preliminary process a matter of some importance ?—It was of importance compared with the bare thread.

Then you did not see a filament manufactured simply according to the direction in this specification ?—No. I have not seen a mere untouched thread of cotton or flax forthwith carbonised; but I believe you could be satisfied on that point.

You have not seen any filament manufactured under the directions of this patent of Mr. Edison ?—I must again say that, according to my judgment, that which I saw in New York was certainly made under this specification, which says, "any fibrous vegetable substance," and that thing which I saw being made in New York was most certainly a fibrous vegetable substance. I cannot therefore agree that I have not seen anything made under this specification.

Then you regard this subsequent patent as unnecessary ?—That is a question of patent law. I can quite understand that a man may have a patent, and then have a patent for details afterwards.

The Court then adjourned till the next day.

Wednesday.

Sir FREDERICK BRAMWELL, in further cross-examination by Mr. Finlay, on Wednesday, said that the cotton thread he saw prepared had been treated with sulphuric acid.

What was the process of carbonisation applied to the cotton thread ?—It was put into a vessel surrounded by pounded charcoal and heated. It was either linen or cotton thread. I did not follow the same thread through all the processes, but I saw the various processes.

Was the thread stretched upon a sort of mould ?—Yes. There was a certain thing in connection with the carbonisation which I do not wish to mention, but the thread was so placed as to retain its shape during carbonisation. By this means the amount of "wasters" was diminished, and a larger number of useful filaments was obtained than you would otherwise get.

The object bring to prevent distortion ?—Not to prevent distortion, but to prevent waste by breakage.

Were the filaments tied down to this mould ?—Only by being passed round. I am not quite sure whether the vessel used was formed of plumbago or iron.

His LORDSHIP: A crucible ?

WITNESS: Crucible shape, but not crucible material. It was packed with powdered carbon.

Was a little paraffin or any substance of that sort put in ?—I have no reason to suppose so.

Is not the absolute exclusion of air an essential feature in this process of carbonisation ?—I should say so. Otherwise you run the risk of burning instead of carbonising.

Had the carbonisation of filaments ever been carried on before, to your knowledge, in England ?—Not to my knowledge before the date of Mr. Edison's patent.

Mr. FINLAY: Do you think that any ordinary intelligent workman, in 1879, would have known that it was necessary to pack the jar in the way you have described with powdered carbon ?—I think he would have known it was necessary to pack it either with that or sand or some material which would form an effectual barrier to the access of air.

Would sand be effectual ?—I think you will find that certain prior patentees have used it.

Then you think that the direction in the specification for "proper carbonising" is sufficient, because an ordinary intelligent workman would have recognised that exclusion of air was necessary ?—I think so; so far as I know all carbonising is done by exclusion of air, from the very burning of charcoal in a forest, to the burning of charcoal for gunpowder, which is very carefully done. I do not know whether there is any definition in a book, but carbonisation to me conveys the idea of heating matter containing carbon to a large extent, which is inflammable in the open air, but heating it in such a manner that the air does not get to it.

Is the necessity for the stretchers or the interposition of plates a matter that would have occurred to any ordinary skilled workman at the time of this patent ?—Probably not immediately, but directly he began to manufacture on a commercial scale I think it would be adopted. I may say that the bamboo filaments are not wired. They are simply packed together in a mould.

If the cotton thread were treated in the way you describe without being subjected to the preliminary stage of parchmentising by sulphuric acid, would it yield a filament that would work ?—I believe so.

Questioned as to whether the rubbing of a fibrous vegetable material with a plastic compound (which was one of the processes in the specification) would not result in a filament which would be so friable as to be useless for the purposes of electricity, witness said he believed, as a matter of judgment, that it would not.

"If the carbon thread is liable to be distorted it is to be coiled between copper wire." Does not that indicate that the heat to be employed was lower than the point at which copper would fuse ?—I presume so; that is the heat of carbonisation, not the heat of the lamp.

Before you got to the heat of the lamp the copper would have been removed by the acid ?—Yes.

Is not the temperature used and necessary for carbonisation something approaching 3,000 F. ?—I do not know whether it does not vary with the time. I am not at all clear that by continual application of a lower heat you do not attain the same result as by a shorter application of a higher heat.

For the successful manufacture of a lamp of this kind, is it necessary that the gases in the carbon filament should be occluded ?—I think it is highly desirable, for commercial success; that is to say, a lamp with that process is certainly better than a lamp without it.

The filament would otherwise wear away ?—I have no doubt the life would be materially shorter.

By combustion ?—Either by combustion or by washing, probably by washing.

Is the effect of that combustion that there is a deposit on the bulb ?—Yes.

In the bulb itself there is a certain amount of moisture adhering to the glass even after a vacuum is produced ?—I believe there is an extremely small amount.

What is the advantage of using a filament for the purpose of an electric lamp ?—It enables the ordinary lamps that are required for domestic purposes or in this court to be supplied by a current of comparatively high electromotive force, thereby diminishing the size of the conductors, which is what the patentee states. As an illustration, there are now laid throughout London hydraulic mains for the purpose of supplying power for lifts and things of that kind. The pressure is 700lb. to the inch. Supposing you diminish that pressure to 100lb. you would require seven times the volume of water, and mains competent to deliver seven times the quantity.

That was thoroughly understood before Edison's patent was taken out ?—Yes; it is quite clear that Lane-Fox understood it. It is equally clear that Edison did not know that anybody else knew it. I do not think it was common knowledge.

Was it not generally known to electricians of experience in this country ?—With the exception of Lane-Fox I do not think anybody had got the idea that it was desirable to get a lamp of high resistance.

Did not electricians of experience know that by increasing the resistance you could diminish the main ?—Oh, certainly; or rather that by increasing the electromotive force you could get the same effect with smaller mains.

And the advantages of increasing the resistance by diminishing the sectional area have been pointed out by Lane-Fox and by Edison himself in previous patents ?—I am not clear about Edison, but Lane-Fox certainly.

Then is not the only new feature in Edison's patent now under discussion the use of carbon of small sectional area ?—I cannot say it is the only new feature. I should say that the feature of the patent is that he made the first commercially successful carbon lamp to carry that desideratum into practice.

Had not Swan, in 1879, before the date of Edison's patent, produced electric lamps with carbon burners ?—So I am informed; a lamp, or lamps.

Did Mr. Swan produce lamps before the date of Edison's patent with carbon burners, sometimes in the form of a carbon stick and sometimes in the form of a filament ?—Yes, as regards the latter part of the question; and no, as to the other.

A lamp was produced and handed to witness, and he said it looked like the lamp which he had seen before.

The ATTORNEY-GENERAL hoped it would be carefully handled, as it was the only one.

Mr. FINLAY: In that the filament or rod, or whatever you choose to

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call it, is straight. In other lamps which Swan made was not the pencil or rod of carbon thinner and in a curved form?—I have no knowledge of any other.

Now take that lamp produced, with a carbon pencil straight between two points, what do you say is the difference between it and a lamp made under Edison's patent?—In my judgment that carbon rod or pencil has been made after carbonisation—that is to say, it has been formed out of a piece of charcoal, and I believe it to be a lamp of very low resistance; incompetent, therefore, to attain the end that Edison desires to attain.

What leads you to the conclusion that the filament there was formed out of carbon already made?—It is one of these straight sticks which I should expect would result from such an operation.

Is that your only reason?—I think that is my only reason. It is a stick perfectly competent to have been made out of a piece of prior existent charcoal. I do not know whether, by examination with a microscope anything could be seen that would alter my answer.

What leads you to the conclusion that that is a lamp of low resistance?—The large diameter and the short length. I can only judge by that. But assuming the diameter to be even as little as one twenty-fourth, yet a common diameter of one of these filaments is one-thousandth of an inch, which would give one ten-thousandth as the area, and the resistance would be inversely to the area.

Then what is the difference between Swan's lamp and Edison's lamp?—The difference is that in Edison's lamp you have this small sectional area.

Then it comes to this—that Edison patented a process for making a filament with a small sectional area?—I would rather not say that. He obtained a process for making a filament that would attain the end he wanted, and I think that was done by him for the first time.

Here are some specimens of conductors which I suggest were made by M. Carré in pursuance of a process that he had practised long before Edison's patent, and used by Swan and Stern; do you recognise them?—No; I know nothing about them.

Would you say that the filaments had been formed before carbonisation?—Their appearance is certainly consistent with that.

Carbon had been in use for incandescent lamps?—It had been proposed by King and by Scott.

Would you call those burners of M. Carré's filaments?—I do not know. They are very large filaments. Two of the long ones might be called filaments. I do not know where the term would begin or end.

Now, with regard to Cheesborough, have you seen the process, as used by the defendants, of flashing?—Yes. It consists in placing the filament in a vessel filled with coal-gas, and then passing an electric current through the filament, until the point of decreased resistance is reached, occasioned by the deposit of carbon on the filament, which is indicated on the galvanometer.

Is not the only object of that process the making of all the filaments of the same total resistance?—I do not think so.

That is one object, is it not?—It is one result.

Is there any other object?—I think so; the obtaining of a filament which in itself gives a uniform light, and having a deposit of carbon of very good quality.

Are not the filaments made by the defendants' process such as not to require the flashing for the purpose you have just mentioned?—I do not know. I have had no means of testing it.

It is a form of carbon deposit, a sort of graphite, is it not; by the application of heat to carbon in coal gas it is decomposed, and there is a carbon deposit in the form of graphite?—I believe so, but I would rather leave that to the chemists.

It has been known for a very long time that by the application of heat a deposit of carbon of this kind could be obtained from such a gas as coal gas?—Yes; I knew it as long ago as the date of the Nassau balloon—forty or fifty years ago.

King's patent of 1845 says that the form of carbon found in gas retorts which have been long in use is well suited for this purpose, and may be worked in the form of pencils. Is not that form of carbon the same substance as is deposited by this process?—I should doubt it. At all events Cheesborough does not think so, because he refers to this kind of carbon as unfit for the purpose.

It is like it?—I would rather leave that to the chemists. Cheesborough says he is going to cure it.

In Harrison's patent, he says that one of his improvements consists of placing a piece of metal in a gas retort for the purpose of receiving a deposit of gas carbon. That is the same form of deposit, is it not, but effected by the application of external heat instead of a current of electricity?—Yes.

It is done by the application of furnace heat?—Yes.

But it is the same process?—Certainly not. It departs so entirely from it that I cannot assent to its being the same process.

The chemical process is the same; it is a deposit of hydrate of carbon?—I cannot assent to its being the same process.

Referring to Jacquelin's patent, No. 2,556, that is the same chemical process, using external heat, is it not?—It seems to be the same as the previous one, except that he takes a purer material—he uses heavy oils.

And the same process is explained in a paper by M. Sidot?—He employed sulphate of carbon and a variety of other things. He succeeded in making charcoal so dense as to be sonorous, and he made a bell of it.

That is by the application of external heat?—Yes. There appears to be this distinction between this process and any you have previously referred to, that the change of wood into carbon, and the deposition of carbon, are going on simultaneously. Whether that has any effect I do not know, but if carbonisation is done first we do not get this sonorous carbon, and when we do it simultaneously we do get that result.

In a paper by M. Deprez published in the *Comptes Rendus* in 1841, this process is described as taking place by electricity, is it not?—Yes, as regards portions of it; he tried it in the arc.

Experimenting for the volatilisation of carbon he found this result accidentally?—Yes; his sole object was to find whether he could fuse or volatilise carbon by heat generated by an electric current.

In the course of that paper he describes the obtaining of exactly the same result as pointed out in Cheesborough's patent, does he not?—I think he does. I am not clear whether he does it by Cheesborough's process or not. Deprez tried experiments sometimes by passing an electric current through and sometimes by subjecting the thing on which he was experimenting to the heat of an electric arc, his object being fusion. He then tried a vacuum and azote, and then hydro-carbon. Whether it was heated by a current through wire or in the arc I do not know. It seems to me a matter requiring consideration.

Subject to that it is the same thing?—Yes, but there is nothing there to disclose the advantage for electric lighting purposes. It appears to me that there was not that gradual application of the current which Cheesborough points out. Deprez only desired destruction, and there was no reason why he should do so by gradual steps.

What do you say there was new in Cheesborough's patent?—The disclosure that by electrically heating carbon in a proper liquid or gas atmosphere, you cured the defect that he points out as existing in retort and other carbon for incandescent electric lighting purposes.

He mentions beeswax, balsam and oils; do you treat those as hydrocarbon?—I presume so, but I would rather leave it to the chemists.

He says almost any hydro-carbon would answer; what do you understand by "surrounded by carbonic gas of a very high temperature"?—Such carbonaceous gas as would result from the heating of hydro-carbon. Carbonic gas was what Deprez was trying to obtain—that is, the vapour of pure carbon.

He says the invention is not confined to the treatment of carbon alone, since it is obvious that many fusible substances, non-conductors of electricity, might be heated so as to cause them to be conductors; what does that refer to?—It seems to me to be a sort of guarding clause.

Re-examined by the ATTORNEY-GENERAL, Sir Frederick Bramwell said that he did not find in any other patents that Mr. Edison's patent had been anticipated. He did not think that any practical person acquainted with carbonisation would have any difficulty in carbonising in accordance with the terms of Edison's specification.

Do you think that for practical purposes, even now filaments could be usefully made except by forming them before carbonisation?—No.

You stated that the application of furnace heat was not the same as the application of internal heat—what is the effect upon the deposit?—Where heated from without, no matter what may be the varying section of the thing heated, it is heated uniformly, and the deposit is uniform. When heated from within, the heat is greatest at the thinnest parts, where it is most required, and the increased deposit goes to make greater uniformity throughout.

In Cheesborough's specification it is stated that carbon of the ordinary sort heated by the electric light exhibits lines of unequal brilliancy, and as the carbon was increased in size more current is required to maintain its temperature. In any one of the alleged anticipations do you find any remedy pointed out, or any directions to cure those unequal points of brilliancy by heating with an internal current?—No, not in any one of them. I think I am right in saying that among all the anticipations relied on there are only two wherein there is internal heating by electricity.

Sir HORACE DAVEY: Which are those?

WITNESS: One is Sir William Groves, who heated a metallic wire; and the other is Deprez, assuming that when he did give this heat he used the hydro-carbon gas, which there is much doubt about, as he was heating for purposes wholly unconnected with electric lighting.

Would anybody be led by Deprez's process who desired to find a carbon for electric lighting?—No; I do not think there is any disclosure in that process that would ever lead to an improvement in carbon for an electric plant.

Dr. JOHN HOPKINSON, who was the next witness called, stated that he had given great attention to electricity for many years, and had followed the development of incandescent lighting from the very first. He believed that one or two of the first incandescent lamps that were brought into this country were sent to him. Dealing with the provisional specification of the patent No. 4,576, of 1879, which was the one relied upon by the plaintiffs, he considered that the descriptions given were undoubtedly sufficient to enable a workman to construct the lamp. He agreed generally with Sir Frederick Bramwell's evidence with regard to the various points in the specification.

With regard to this invention having rendered electric lighting practicable on a large scale, what is your opinion?—I do not think there is a shadow of a doubt about it. Before this patent there was no commercial incandescent lamp at all, and immediately after it, or almost immediately after it, incandescent lamps were sold in considerable quantities.

And the electric lamps that have been made and sold generally since the patent, are they made in accordance with the invention?—I think practically all of them are made in accordance with it; no doubt in some cases with improvements in detail.

Now, with regard to the difficulty that has been suggested of carbonising so small a body of carbon, in your opinion would a competent workman find any difficult in doing it?—No; I think it had already been disclosed that one way was to enclose the body to be carbonised in plumbago, and then apply to it a higher temperature; and that is a tolerably obvious way of doing it.

In your opinion would the necessity of some care in carbonising so small a body be obvious?—Yes; it is very clear that with so small a body as a thread the presence of even a small quantity of oxygen would burn it. You must therefore provide something that would combine with it, such, for example, as plumbago or powdered charcoal of any kind.

Do you agree with Sir Frederick Bramwell's evidence as to the effect of

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coiling and the novelty and utility of the patents relied on by the plaintiffs?—Yes.

Cross-examined by Sir HORACE DAVEY: The first incandescent lamps were shown to him before the time at which the original Edison Company was formed, and certainly subsequent to Edison's patent. If the Edison Company was established in 1882, it was in 1881 that he saw the first lamps.

Do you not know that all through 1880 and 1881 Mr. Swan was making and selling lamps?—I believe he was. I do not know that I saw them, but it is possible.

Perhaps you were at the Electrical Exhibition in Paris in 1881; did you see Swan's lamps there?—I was there, but I do not remember seeing Swan's lamps there. I saw Edison's.

Mr. MOULTON: Do you suggest that Swan's lamps were sold in 1880?

Sir HORACE DAVEY: Yes, and exhibited. Will you tell me, Dr. Hopkinson, if you ever in the course of your life saw a single lamp made exclusively from the directions in the patent without the aid of subsequent inventions or subsequent directions?—Yes. I think that a lamp has been shown to me that was made from a composition of tar and lampblack, or something of that kind, at the time of the last action. I do not know whether it was put in evidence, or whether it can be produced now.

Sir HORACE DAVEY: I should like to see it.

WITNESS: I have not got it.

You do not know how the burner was made?—Not of my own direct knowledge, but I was told how it was made.

You do not know how the burner was attached to the conducting wires?—That I do not distinctly recollect, but my impression is it was attached in the same way as described in Edison's specification.

With the exception of that lamp did you ever see any lamp made exclusively from the directions in the specification?—I do not know that I have seen any lamp without some of the subsequent so-called improvements being introduced.

The burners in the lamps which the Edison Company are selling now are not made in any of the ways pointed out in this specification, are they?—They are made in the ways pointed out in this specification with the addition of improvements in detail.

They are made of parchmentised threads, are they not?—I believe that is so.

Treated in the way that Sir Frederick Bramwell referred to, and did not wish to explain fully?—Yes.

You never saw them made with a thread of cotton simply carbonised?—I do not recollect it, but I may have seen it.

Did you ever try to carbonise a thread from these directions?—No; I have never attempted to carbonise a thread or anything else.

Was there any experience prior to the date of Edison's patent of carefully carbonising threads and fibres?—Not that I know of.

So that your view is that it was a new manufacture?—Yes.

And therefore I suppose there would not be workmen engaged in carbonising threads?—Certainly not.

Do you find in Edison's patent any directions to workmen except the bald direction that they are to carbonise?—No; I think not.

Would not the effect of carbonising a thread of cotton or linen or fibre, such as he refers to, in a close vessel and applying great heat, without any further operation, merely be to distort or crinkle it?—Unless you fill up the space in the closed vessel in some way, no doubt the filament would be actually burnt.

Would it not require experiment and thought, and the application and some mental process for the workmen to find that out?—No experiment and very little thought.

Some thought?—No doubt some thought.

He would have to try what was the best material to use?—No; I think the quality of materials in that respect is very well known. The slightest knowledge of chemistry would tell a man that there would be sufficient oxygen in the vessel to burn that filament, and he would fill it with some carbon, I should imagine.

You do not agree that sand would do?—No; I doubt it. I think it would leave too much oxygen. It might do for a coarse filament, but for a fine filament, such as we have here, I do not think sand would do.

Supposing that a workman tried sand first?—He would find that his filament would be burnt if it was a very fine one. You might use plumbago powder.

Amongst other materials which Edison proposed to use were strips of paper?—Yes, paper coiled in various ways.

Would you say that this imaginary intelligent workman would know how to properly carbonise this strip of paper?—Yes, if he was a bit of a chemist I think he would.

Do you assume that the intelligent workman is a bit of a chemist?—Surely.

Mr. Edison did not think so, because he took out another patent a few months later for the very purpose of instructing him?—I have not looked at his patent for a very long time, and I do not remember.

Refer to his patent of 1879. Does not that contain particular directions for carbonising paper?—Yes; he tells you to pack them with tissue paper between to get them in a small space.

Sir Frederick Bramwell tells us he has seen the making of the bamboo burner?—Yes, I have seen the same in Berlin.

That Edison considered to require a patent?—I am not quite sure that he took out a patent for the bamboo fibre, but here is a patent with 44 claims, and I think it is highly probable he includes the bamboo in one or other of them.

Does not the wording of the patent of 1879 show that at that date Edison was not able to give, and therefore did not give, the necessary directions for making burners?—I certainly think he did; but it is even now an open question whether a structural carbon or one perfectly homogeneous is not better.

Was not Edison's mode of connecting the wires to smear them with putty, and then carbonise the whole thing?—Yes; my impression is that the lamp of which I have spoken was done in that way.

As to this lampblack and putty, mentioned at the bottom of p. 3 of the specification, was the lampblack to be put on before or after the material was carbonised?—I should say it would be rubbed on before it was carbonised.

What do you understand Mr. Edison to mean by saying that the resistance of fibrous material may be high or low according to the quantity of lampblack put upon it?—I understand it to mean that the more lampblack you put on the lower resistance you would get. He speaks of 2,000 ohms. If he has a burner of a higher resistance he can make it to whatever he pleases by smearing this stuff upon it.

I am told you could not carbonise fibrous material at all if it was smeared with lampblack?—I do not think that is the case.

Would it not be burnt or destroyed?—That would depend upon the dimensions of the fibrous material; and even if it were burnt you would still have the lampblack left.

Now, as to this somewhat apocryphal lamp?—It is not apocryphal to me. I saw the lamp. I have no doubt about that.

Have you ever seen a lamp made with this tar and putty?—No.

Have you ever tried the experiment whether tar and putty drawn out in a thin wire and then carbonised would produce a workable practicable filament?—No. I have never tried it myself.

Did you ever know anybody who did?—The lamp which you call apocryphal was, I was told, made in that way.

Are you prepared to say it is a useful or practicable mode?—Oh, yes, it is practicable.

Is it not a fact that an attempt to produce a carbon in this way would produce a piece of carbon that could not be lifted out of the crucible?—No, the lamp which was shown to me had not that property at all.

What is the alternative process that is employed?—The so-called Swan lamps are made from cotton thread.

Parchmentised?—Yes.

That is not in this patent?—Parchmentising is not. Edison now uses wood splints.

Treated in the manner described in the subsequent patent?—Yes, but these are merely matters of detail. He would be able to make them in the way described here.

But he does not describe it there?—He does not describe the cheapest way of making them.

Does not that make the difference between success and non-success?—No; these various improvements have brought out a number of lamps which have nothing in common except that which Mr. Edison describes.

Then the whole point is whether he has given sufficient indication to construct the present make of lamp?—I think he has; but the expression may be somewhat loose.

There are a good many loose expressions in this specification, are there?—Yes; but you can understand what they all mean.

When this burner is carbonised it would be no longer flexible?—It would be flexible, but it would spring back again.

What do you say as to oxide of zinc and camphor?—Oxide of zinc would burn at the temperature of carbonisation, but camphor might be carbonised.

The witness was examined at considerable length as to what was a filament, and he expressed his inability to define it. There was an extreme at one end which was, and an extreme at the other which was not, a filament; but when it came to the border line he could not fix any limit.

A large Edison incandescent lamp of about 800 candles was handed to the witness, but he declined to say whether the burner was a filament or not.

The principle of high-resistance lamps was known to electricians and to Lane-Fox before the date of the Edison patent?—Yes, it was known as a desideratum.

For the purpose of a single lamp there is no advantage in a high-resistance lamp?—There are one or two advantages. You can use smaller wires.

But the chief advantage in a high-resistance lamp is that you can use it in a multiple arc or a series?—In a multiple arc, but not in a series. You may use a low-resistance lamp in series, because you have not to take a large current to any one lamp.

Questioned as to Lane-Fox's provisional specification of March, 1879, in which mention was made of magnesia, zirconia, lime, steatite, and other earthy matter, witness said that in that case it was proposed to mix non-conducting material with conducting material, which would increase the resistance vastly. It would make a thicker conductor with a higher resistance.

Does not the latter part of that describe a vacuum?—Yes; but it is possible he might contemplate filling it with nitrogen.

His LORDSHIP: The principle of the high resistance of the carbon conductor was not disclosed before the date of Edison's patent?

Witness: No.

Sir HORACE DAVEY: But the scientific principles which rendered high-resistance valuable were known before?—Yes, as a desideratum.

And it was also known that in order to get high resistance you must reduce the size of your cross-section?—Yes.

The case was adjourned till the following day.

THURSDAY.

The cross-examination of Dr. Hopkinson by Sir Horace Davey was resumed.

Sir HORACE DAVEY asked if Lane-Fox's specification of his patent

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of 1878, No. 4,626, did not exactly describe one of Edison's modes of making his filaments, in which he coated it with a non-conducting, non-carbonising substance, so far as the position of the burner was concerned.

WITNESS said it did, no doubt, so far as regarded the covering with non-conducting material. Lane-Fox referred to the burner as a strip or wire. He did not, however, understand that the burner was to be necessarily in the form of a strip or wire, but that was his opinion. Looking back to the specification of 1878, he agreed that the object of the inventor was to obtain a burner of high resistance, as it undoubtedly was in the earlier patent.

Is "strip or wire" one of the expressions used by Mr. Edison himself in his specification?—I think he uses the expression.

I think in the third claim he used the word filament or strip?—No doubt.

So that "strip or wire" is one of the many words which Mr. Edison uses in the course of his specification for denoting his burner?—He describes it so; but, of course, wires may be of various sections.

A little round lamp of the Edison Company was then handed to witness. He said he considered it contained a filament. The resistance of that lamp he thought from its appearance might be five or ten ohms. He would not be surprised to hear that it was only two ohms. Notwithstanding the low resistance, he would speak of the thread as a filament, as that was a term independent of resistance entirely, as used by Mr. Edison in his patent.

In the second claim he does not say anything about high resistance, does he?—No; but it runs through the whole patent.

Then you would interpolate into the second claim the words "a carbon filament of high resistance"?—Yes; I think I should.

A second lamp was then handed to the witness, who said he had the same answer to make with reference to the filament. He imagined it to be a lamp of very low resistance. He considered the two lamps in question to be made in accordance with Edison's patent. He would call two ohms low resistance. Witness did not remember that he was present at a scientific party given at the late Mr. Spottiswoode's house, in London, on 1st December, 1880, and could not, therefore, say whether on that occasion Mr. Spottiswoode's house was lighted with Swan lamps. He had been told that Mr. Edison first publicly exhibited his incandescent lamp in America in 1881; perhaps it might have been a little before that date.

It was not until some considerable time after he took out this patent of 1879?—That I cannot say.

Witness was then asked to look at the carbon of the lamp used by Mr. Swan in his lecture on electric lighting in 1879, and whether he had formed any opinion as to the way in which the carbon used in that lamp was made, and replied that he could not say.

Is there anything in the appearance of it to your practical eye which is inconsistent with its having received its present shape before it was carbonised?—No; there is nothing to suggest it.

It is very similar, is it not, to the carbons which are said to have come from Carré?—Yes. This must have been considerably changed by the passage of the current through it; so there is no telling from the appearance of it in what way it has been made.

Witness was then referred to the Cheesborough patent, and to a statement to the effect that carbon suited for electric lighting was produced in gas retorts. Witness admitted that the filaments (as Sidot calls them) formed on the side of gas retorts were formed by the same chemical process as that described in the Cheesborough patent, but in this broad sense that they were deposited from the hydro-carbon vapour upon a highly heated surface.

To put it in a popular form, it is the decomposition of coal gas coming into contact with the highly heated side of the retort?—Yes.

I do not want to call these products by any name that would prejudice them, but they are filaments in the form of little flakes?—They are described as filaments.

Mr. JUSTICE KAY: I want quite to understand—you mean that what is produced in the gas retorts is in the form of filaments?—It is the deposition as the air condenses of carbon on the surface of the retort.

Sir HORACE DAVEY: They have been called flakes?—The surface may possibly be flakey, but broadly speaking the mass is very solid and compact.

Mr. JUSTICE KAY: You are speaking of a gas retort?—Yes; of course, one has practical experience of them.

Sir HORACE DAVEY: I believe a suggestion was made for using these pieces of carbon from the sides of gas retorts as conductors in incandescent lamps, was there not?—Yes.

As long ago as the time of King, in the year 1845, a suggestion was made to use these carbons procured from the sides of gas retorts and adapted to incandescent lighting?—Yes.

What do you say to the statement made with reference to the Cheesborough patent that the heat required to produce the proper character of carbon is as high as 7,000°F.?—I should say I have very great doubt as to whether 7,000°F. is a terrestrial temperature at all. It is rather high.

You would say it is rather a large order?—Yes, most decidedly. We have no measures at all anything like so high as that.

You have no experience of heat of that kind. Probably you would not like to have?—I hope we never shall have [laughter].

But Cheesborough here contemplates that heat of that magnitude is necessary to produce the proper character of carbon, does he not?—No doubt he does.

Do you not infer from that passage that he contemplated that in his process a heat as high as 7,000°F. would be used?—He so describes it, no doubt. No doubt he had an impression that a temperature of that kind could be produced.

I want to make one thing clear. This specification does not contain any directions for gradually applying and increasing the temperature?—Yes.

I presume you will agree with this statement of fact, that as the carbon increases in size more current is required to maintain its temperature? That is known to every electrician?—Yes; but he does emphatically call attention to the necessity for it.

Sir HORACE DAVEY proceeded to read from the specification:—"Carbon pencils may be cut from this deposit (in the retort), or the original pencil with its coating may be used in the lamps." Was not Cheesborough there contemplating a process by which he could create as large an amount of carbon as he required?—No doubt.

Have you compared the description of carbon which he obtains here with the description which Deprez gives of the carbon which was the result of his process?—Yes; they are extremely alike, even in the language of description. So far as the deposition of graphite is concerned I should say they are the same. As regards the position of deposition and so on I should say they are different.

Is that because flakes were deposited by Deprez?—No; I think Deprez had referred to the electric arc.

In answer to further questions witness said that, so far as material went, the material which Deprez found in the course of his experiments, after he had wiped off the sooty deposit, was identical with the material produced by the Cheesborough process. One material might be a little harder than the other, but, broadly speaking, they were the same. The greater hardness would, no doubt, result from the better or more careful application of the process. Cheesborough did not confine his process or his material to carbon.

Have you had your attention called to this passage: "The invention is not confined to carbon alone, since it is obvious that many infusible substances, which are non-conductors of electricity, may be heated in carbon liquids or gases so as to render them conductors of electricity." Is that obvious to your mind?—No.

Is it true that you can do it?—Yes, I think you can do it. I have not tried it.

Might there be a deposit on a non-conducting substance, as, for instance, fireclay?—Yes, if you had a conductor within it.

Sir HORACE DAVEY: But would there be a deposit of carbon on a non-carbonisable substance?—Oh, yes; if you had a conductor through it so as to be able to raise to high temperature so that you could deposit carbon upon it.

You say you can get a deposit on non-conducting material—steatite, for example?—Oh, yes.

Mr. Justice KAY: If heated to a certain temperature?—Yes.

Sir HORACE DAVEY: Then suppose you took a tube of lime enclosing a pencil of carbon through which the electric current is caused to circulate, a tube of lime would be a non-conducting, non-carbonisable material?—Yes.

Did you ever try the experiment?—No.

Do you expect that you would get any deposit of carbon whatever in the lime?—I should doubt it; possibly on the surface.

Now suppose you took your pencil or rod which you thus obtained and put it into an incandescent lamp; have you ever tried that experiment?—No.

What do you think would be the effect of the great heat passing through the conductor upon the line?—It would depend, of course, upon what temperature you push it to. No doubt you could get it to work, though not efficiently, according to the standards of the present day.

Would it not have this effect—that the oxygen in the lime would combine when more heat was applied?—I do not know what the heat passing through a conductor would be, it would be very high.

Would not the effect be that the oxygen of the lime would act upon the carbon, or the carbon would act upon the oxygen, and the carbon would in a short time be destroyed altogether?—I do not think so. Of course, I am only speaking from a general knowledge, not from expert knowledge as a chemist.

You observe that in his first claim he describes his method as a method of preparing the illuminating part of an electric lamp. Do you confine that to incandescent lamps?—I have always read it so.

Witness also stated that he understood by a carbon gas or liquid, a gas containing carbon from which carbon could be deposited; broadly speaking, a hydro-carbon. But the term hydro-carbon was generally used with a somewhat broader signification. Without being enough of a chemist to speak positively, he was under the impression that at a sufficiently high temperature the necessary deposits could be obtained. With reference to prussic acid, he was not sufficiently chemist to answer.

(To be continued.)

JUDGMENT OF THE SUPREME COURT OF THE UNITED STATES IN THE TELEPHONE APPEALS.

(Continued from page 642.)

THE CONDUCT OF DRAWBAUGH CONSIDERED.

Under these circumstances it becomes important to consider the conduct of Drawbaugh in reference to his alleged invention during his twenty years of eventful history, as connected with the discovery and use of the telephone. If his present claim is true his experiments began almost as far back as those of Reis, and he had in his shop at Eberly's Mills, within three miles of Harrisburg, telephones that were substantially perfect months before Bell (on the 2nd of June, 1875) got the clue to his subsequent discovery. It is conceded that D and E, claimed to have been made in February, 1876, are substantially as good magneto instruments

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as any Bell had used before December, 1881; and L, M, G, O, and H, all of which were constructed, it is claimed, between February, 1875, and August, 1876, are as good or nearly as good microphones as those of Blake, which were not invented until 1878. This is the theory of Drawbaugh's defence, as set forth in the answer and in the argument, and by it his case must stand or fall.

The claim is that the discovery of the process was complete, and that perfect telephones had been made and were in a condition for actual use a year and more before Beil got his patent.

Drawburgh was, when he gave his deposition, 54 years of age, and had lived all his life at or near Eberly's Mills, a small village near Harrisburg. He was a skilful and ingenious mechanic, and if he made D and E, and the instruments which came after them at the time it is said he did, he had good tools and good material in 1875 and 1876, and was capable of doing the best of work. He was also somewhat of an inventor, and had some knowledge of electricity. According to the testimony he was an enthusiast on the subject of his talking machine, and showed it freely to his neighbours and people from the country, whenever they visited his shop.

The Centennial Exhibition was opened in Philadelphia in May, 1876. Drawburgh visited it on 17th of October, 1876, remaining four or five days. Before he went he had heard, as he says, that some one besides himself had invented a speaking telephone, which he had the impression was on exhibition there. If what he now claims is true he had then on hand in his shop exhibits D, E, L, M, G, O, and H, all of them good instruments of their kind and capable of transmitting speech, and some of them but just finished. Bell's apparatus had been exhibited to the Board of Judges in June before, and had attracted marked attention. The matter was much discussed in the public press, and yet it never seems to have occurred to Drawbaugh to take any of his telephones with him when he went, although they were small in size, and some or all of them could have been carried without serious inconvenience. When giving his testimony he was examined in chief as to that visit, and this is what he said on the subject of telephones :—

"*Q.* Did you attend the Centennial Exhibition at Philadelphia in 1876?—*A.* Yes, sir, I did.

"*Q.* Can you give the date on which you went there?—*A.* I can by reference to a book. It was October, 1876. The 17th was a day on which I dated a letter from Philadelphia when I was there on that visit.

"*Q.* How long did your visit there last?—*A.* About four or five days, to the best of my recollection.

"*Q.* Who went with you on that visit?—*A.* Mr. George Leonard.

"*Q.* Was that the only visit to the Centennial Exhibition that you made?—*A.* Yes, sir, it was.

"*Q.* At the time you went there, or before that time, had you heard that somebody else besides yourself had invented a speaking telephone or a telephone?—*A.* Yes, sir; some time before that. I do not remember how long, but not a great while.

"*Q.* When you went there, did you suppose it would be on exhibition there?—*A.* I do not remember whether I had heard that it was on exhibition or not, but I got the impression some way that it was on exhibition.

"*Q.* While you were there at the Centennial did you see any telephones or make an effort to see any there?—*A.* Yes, sir; I made an effort and saw an instrument called a telephone and supposed it to be the instrument spoken of; the one of which I had heard. I was looking and had made some inquiry, and was directed or came to a portion of the building where I saw on a counter some man's telephone, the name I do not remember. At that time or several times that I called, there was no one there to attend to it. I spoke to another party that had something else on exhibition, I do not recollect what it was, just near by, and I asked him whether there was any one there to attend or show the instruments. I was informed then there was no one there to show them.

"*Q.* If you remember, please state what kind of an instrument it was that you saw there, and state what information you were able to obtain there regarding it and its mode of operation?—*A.* There were a number of instruments placed on to a raised portion, something like a shelf; that is, it resembled something like pigeon holes, a box open in front, and each instrument at the back of it had an electro-magnet. The number of instruments I do not remember. I do not remember counting them. If I am not mistaken there may have been a dozen or more. Perhaps some were larger than others. I cannot give you a much better description than that. I could not get any information about them. This attendant made some remarks about the instruments, but he did not understand them and could not explain them. I was several feet from where the instruments were. They were on a raised place like a shelf, just about high enough for a man to speak into. That is the way it looked to me. I did not go in behind the counter to examine them.

"*Q.* Did you see any circulars lying around there referring to these instruments or any advertisements of them?—*A.* I do not remember about that. It may have been.

"*Q.* What was your impression as to the character of the instruments when you finally left them?—*A.* I was impressed with the idea that they were instruments to telegraph by sounds, a certain sound to represent a certain letter of the alphabet. I am not certain how I got the idea, or whether any person told me that at the time, but that is the idea that I had.

"*Q.* Do you know whether that was Gray's harmonic telegraph that you saw there or not?—*A.* It did not say 'telegraph.' I am confident it was called telephone. I did not see the working parts of the interior except the electro-magnets. I took the name of the man and his address on a piece of paper, and put it in my pocket, but I do not know what became of it. I do not know whether it was Gray's harmonic telegraph or not.

"*Q.* Did you see any tuning-forks about it?—*A.* I did not."

That was all he did during his entire visit to ascertain whether anyone besides himself had actually entered upon this new and interesting field of invention and discovery. He spoke to no one about what he had done himself. He made no special effort to find out whether that which was on exhibition was in any respect like what he had at home; neither did he when he got home, as far as the record shows, say anything to his neighbours or visiting friends about what he had seen or heard. He had apparently lost all interest in talking machines.

Not so, however, with his other inventions. The testimony shows that during the early part of 1876 he was much occupied in building an electric clock, which he thought of exhibiting at the Centennial. This he did not do, however, but several days before he went to Philadelphia, or soon after, Rufus E. Shapley, a jeweller of Mechanicsburg, went on his suggestion to Eberly's Mills to look at the clock which he had made. Soon after that the clock was taken to Shapley's store in Mechanicsburg, and on the 8th of November, 1876, Drawbaugh, by an instrument in writing, transferred to Shapley a one-half interest "in the clock I am getting up, the said Shapley to pay for patenting the same." Shapley had then $2,000 in money, which Drawbaugh was anxious to have him invest in this business. The clock was taken by him to his shop so that it might be examined with that end in view, if it should prove to be useful. Some time afterwards it was taken back to Eberly's Mills, where it remained until April 1st, 1878, or thereabouts, when a clock company was formed, and this clock, or another one substantially like it, was taken about the country for exhibition. For this Drawbaugh was paid $500 and an interest in the profits.

On the 20th of September, 1878, he applied for a patent for improvements in batteries for electrical clocks. The patent was issued January 14th, 1879, to the members of that clock company. The enterprise does not seem to have been productive of any very great success.

In November or December, 1878, while this clock was on exhibition, Drawbaugh was introduced to Edgar W. Chellis. He had with him at the time a wooden model of a faucet that he wanted Chellis and another man to take a one-third interest in. An arrangement was made by which Chellis got a two-thirds' interest, he paying $250 for it January 7th, 1879. On the 14th of the same month Drawbaugh filed in the Patent Office an application for an improvement in rotary measuring faucets. After this application an interference was declared, March 27th, 1879, between Drawbaugh and David A. Hauck, who had filed an application. In his preliminary statement in this interference Drawbaugh said he had conceived the idea of his faucet in the fall of 1869, and made a working model in 1877, and the Patent Office model was not completed until about the 1st of November, 1878. The case was closely contested and finally decided in favour of Drawbaugh, January 15th, 1880. The patent was granted to him and Chellis, July 6th, of the same year. In this contest Jacobs and Hill, who afterwards became interested in the telephone claim, appeared as the counsel for Drawbaugh.

On the 2nd of July, 1879, Drawbaugh filed another application in the Patent Office for an improvement in water motors. Chellis was to have in this also a two-thirds' interest. On this application a patent was issued March 16th, 1880.

DRAWBAUGH'S CONDUCT INCONSISTENT WITH HIS CLAIMS.

It is impossible to believe, if Drawbaugh had in his shop when he reached home from the Centennial exhibits D, E, L, M, G, O and H, or even D and E alone, that he would have set himself to work in the first instance in developing the clock enterprise or perfecting his former conception of the measuring faucet, instead of calling attention to his great discovery of the telephone, which he was in danger of losing by a patent which had been issued to another, and which he could not but have known was even then attracting the greatest attention. In this connection it must be kept in mind that the theory of the defence, as stated in their answer, is that Drawbaugh had at that time fully perfected his invention, and that while at first "he conceived that its range and capacity for usefulness to the public might be very greatly enlarged," he had before the date of Bell's patent, "notwithstanding his impoverished and embarrassed pecuniary condition and his utter want of proper mechanical tools," finally perfected his work. His conduct, therefore, is to be judged, not as of one who was still in the midst of his experiments and doubtful as to the results, but as of one who had arrived at the end, and completed his success. No man of his intelligence, with or without the enthusiasm on the subject which it is said he possessed, could remain silent under such circumstances.

As we have read the testimony, it is not even pretended that he took any of these instruments outside of his own village until May, 1878, when, as is claimed, he showed one to his friend Stees, in Harrisburg, whom he had known for years, who was the first to use, and in fact was then using, a Bell telephone upon a private line of his own between his office and his shops. This produced no results, and when afterwards, in January, 1879, Chellis was told that Drawbaugh had a phonograph and a telephone that he had invented, he gave it no attention, because, to use his own language, "I was interested in the faucet and motor business, and wished to push them, and I did not think we could do much with a telephone, as Bell had a patent, and I did not know that he could ante-date it."

Again, when speaking of a conversation he had with Drawbaugh, he said, "I advised him to drop the telephone, as he could not ante-date Bell. He said he did not know about that—that he had been working on it a good while. It was his way of expressing himself when I would say, "You cannot ante-date Bell." He would say, "I do not know about that; I have been working at it a good while."

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This, it must be remembered, was in 1879, after the telephone had become a success, and after it had been a year or more in use in Harrisburg, where Chellis lived. It is impossible to believe that either Chellis or Drawbaugh was ignorant of the approximate time of Bell's invention, which had been the subject of frequent newspaper comment from the time of its exhibition at the Centennial. The subject was often referred to in the Harrisburg and Mechanicsburg papers, and it is not for a moment to be supposed that all these various articles escaped their attention. Under such circumstances, if it were true that Drawbaugh had made his D and E, as is now claimed, in February, 1875, he certainly would have said so, and he would not have contented himself with so doubting an answer to Chellis's suggestion of his inability to ante-date Bell, as that which Chellis now says he gave.

Another important fact in this connection is one which is proved by the testimony of Andrew R. Keifer, who from 1863 had been division telegraph operator having charge of the middle division of the Pennsylvania Railroad, and resided in Harrisburg from 1863 to the winter of 1881. He was a member of an electric firm in that place, engaged in the manufacture of burglar alarms, instruments for the signal bureau, &c. He had also since 1876 kept a place for the sale of electrical supplies. He had known Drawbaugh since 1876, and probably before. Drawbaugh met him on different occasions in the course of their acquaintance and talked with him on electrical matters. In the course of their acquaintance, Drawbaugh showed him an electrical fire-alarm apparatus, and the working of his electrical clock, but the subject of telephone was never alluded to between them until the summer of 1881 when this occurred (we quote from the deposition of Keifer) :—

"In the summer of 1881, I took my wife out for a drive and went over to see his works, never having seen them, and having promised him to come and see him some time ; my wife not caring about going to the shop remained in the carriage, and I went through alone with Mr. Drawbaugh. He showed me through the shops and introduced me to Mr. Chellis, and showed me parts of the water-motor and some other things of his getting up. On account of my wife being in the carriage alone I did not stay long. As I stepped into, or was just in the carriage, Mr. Drawbaugh said : 'I forgot to show you my telephone !' I did not get out again to go and see it, and I drove away without seeing it, expecting to see it again, but I have never got over to the shop since."

This was after the suit of the Bell Company against the People's Company was begun, and of course after the matter got into the hands of Chellis and his associates. It is no answer to the criticism of Drawbaugh's conduct in this particular to say, as was said in the argument, that one reason why he not speak or apply to every man with whom he had a personal acquaintance was that he was ridiculed by his neighbours ; that his invention was considered a humbug by them and of no commercial value. Bell's success was proclaimed in the Harrisburg *Patriot* as early as February 26th, 1877, and the age of ridicule was then past. If Drawbaugh had at that time in his shop the machines it is now claimed were there, complete as they now are, in August, 1876, and most of them before, there cannot be a doubt that he would have taken them to some place where they could be tried, and show that they would do what he had all along claimed for them. All he had to do at any time after he came back from the Centennial was to take any pair of his little instruments to his friends at Harrisburg, attach them to a line wire, and show what he had. They were men who could appreciate the telephone and help him if it was, as he now says it was, a success. It would certainly have been easier then, within two years of the time the first of them was made, and within a year of the date of Bell's patent, to show that he ante-dated Bell, than it was three years afterwards, when he was brought into the controversy through the instrumentality of his associates, not, as must be evident to all, to get a patent for himself, but to defeat that of Bell.

In this connection it is specially significant that the application which it was claimed was made for a patent on the 21st of July, 1880, and the specification of his invention which was then written out, have been purposely and designedly kept out of the case, although their production was demanded. They were written before this suit was begun, and it is impossible to believe that they would have been withheld, at least upon the call of the opposite party, if they were in all respects consistent with the subsequent development of the case. The excuse given by counsel at the time. that they were in the secret archives of the Patent Office, and if produced and published in this case would possibly invite the filing of contesting applications and result in an interference and additional litigation, besides unnecessarily prolonging the taking of testimony and increasing the expenses, we cannot accept as satisfactory, in view of the fact that in the answer it was said that one object of filing the application "was to procure interference proceedings to be instituted against the patent of Bell, in order that Drawbaugh might be adjudged by the Commissioner to be, as he rightfully is, the original and first inventor."

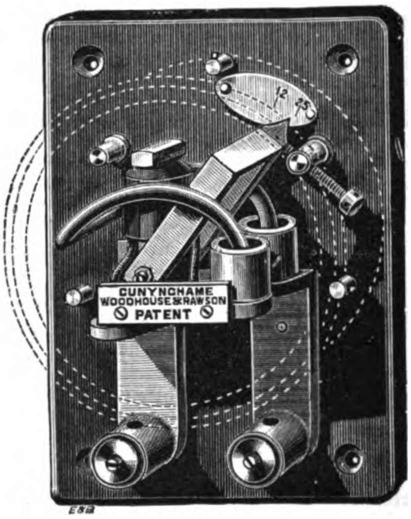
We have not overlooked the depositions that have been taken in such large numbers to show that Drawbaugh was successful with F, B, C, I and A, before D and E were made. They have been studied with care, and if they constitute all the testimony in the case it would be more difficult to reach the conclusion that Drawbaugh's claim is not maintained. But in our opinion their effect has been completely overcome by the conduct of Drawbaugh, about which there is no dispute. From the time of his visit to the Centennial until he was put forward by the promoters of the People's company, nearly four years afterwards, to contest the claim of Bell, he was silent, so far as the general public were concerned ; while if he had really done what these witnesses say he did, he would certainly have spoken. There is hardly a single act of his connected with his present claim, from the time he heard, before going to Philadelphia, that some-one else had invented a telephone which was on exhibition at the Centennial, that is not entirely inconsistent with the idea of a complete discovery or invention by himself which could be put to any practical use.

It is not pretended that what he did was done in private. He had influential friends, with ample pecuniary resources to help him in bringing out his inventions when they promised success. He easily got aid for his clock and for his faucet. The news of Bell's invention spread rapidly, and it took but a few months to demonstrate to the whole world that he had achieved a brilliant success. No one can believe that the public would be kept in ignorance of the invention until four years afterwards, when a special despatch from Washington to the *Cincinnati Commercial* announced a telephone combination to have entire charge of the telephone in this country.

(To be concluded.)

CUNNINGHAM, WOODHOUSE AND RAWSON MAGNETIC CUT-OUT.

Some considerable improvements have been lately made in these well-known instruments. The changes are principally directed towards the better insulation of the various parts and the more accurate working of the instrument. For instance, slate has been employed in the bases instead of wood. The cups which contain the mercury, and one connecting bar and terminal, are now cast solid out of copper, and the arms which dip into the cup are arranged so as to prevent any pos-



sibility of spilling the mercury. Very careful attention has been paid to the balancing and pivoting of the armature, so as to secure uniform delicacy and certainty in its movement. Messrs. Woodhouse and Rawson fit these new type instruments with a glass front cover of a circular shape, which is secured by a bayonet joint, so that it can easily be removed to replace the armature in the cups. One of the new type is shown in the accompanying illustration.

CORRESPONDENCE.

WATTMETER MEASUREMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Mr. Otto T. Blathy's letter in your issue of the 6th instant raises several points on which a little more information would be useful. In the discussion on Mr. Kapp's Paper on "Transformers," at the Society of Telegraph-Engineers, Prof. Ayrton gave on the board the following expression for the ratio of the observed watts to the true watts when the dynamometer wattmeter is employed on inductive circuits :—

$$\frac{\text{Observed watts}}{\text{true watts}} = \frac{r}{r^1} \times \frac{\tau^2 r r^1 + \pi^2 L L^1}{\tau^2 r^2 + \pi^2 L^2},$$

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where r L refer to the fine-wire circuit of the wattmeter, and r^1 and L^1 to the inductive circuit under measurement. If we write T_S for the time constant of the fine-wire circuit of the wattmeter, and T_R for that of the inductive circuit, this correcting factor may be written

$$\frac{1+p^2 T_S T_R}{1+p^2 T_S^2},$$

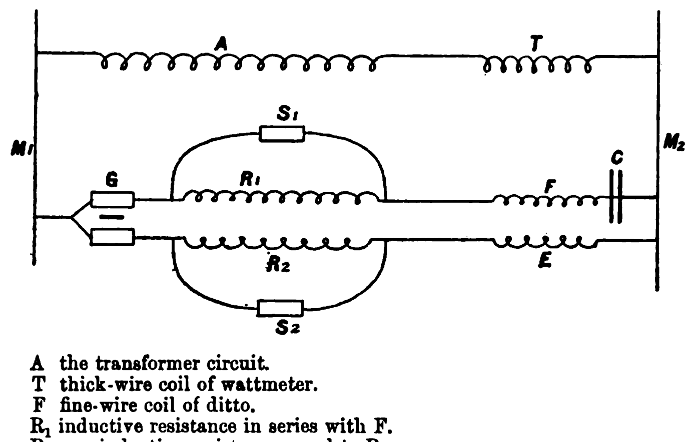
where $p=2\pi n$, n being the frequency; or when T_S is small compared with T_R, this may be written

$$1+p^2 T_S T_R.$$

In this correcting factor, as Mr. Blathy very properly points out, the time constant T_R is that of the primary circuit of the transformer as affected by the state of the secondary circuit; in other words, it is the *effective time constant* for the particular load. This will be largest when the secondary circuit is open, and least when it is loaded to its full capacity.

Mr. Blathy gives 1·000038 as the value of this correction factor for a 10 horse-power Ganz transformer run on open secondary circuit when used with a particular wattmeter. I confess I do not follow Mr. Blathy's figures when he states that the inductance of the fine-wire circuit of the wattmeter so used is ·0002 (earth quadrant ?); is that to be understood as the result of a measurement, and does it include the small inductance of the supposed non-inductive resistance in series with the movable coil ? In the case of the two horse-power transformer used by Prof. Ayrton, assuming that the calorimeter experiments are within reasonable limits of accuracy, the value $1+p^2 T_R T_S$ for open secondary circuit was found to be 1·85.

Either, then, the time constant of the fine-wire circuit, or that of the inductive circuit, is very much smaller in the one case than in the other. I cannot help doubting whether the time constant of Mr. Blathy's fine-wire circuit in his wattmeter is as small as he considers it to be. He has certainly suggested an ingenious method by which the effect of *lag* in the fine-wire circuit of the wattmeter can be annulled by the use of a double circuit, in one of which the inductance is positive and in the other of which it is made negative by using a condenser in series with half the active coil. One objection I see to this method as it stands is that it would necessitate a condenser of very small capacity, unless the resistance of the movable part of the wattmeter is made very small. Another would be found in the fact that, owing to soakage and conductance in the condenser, it would be very difficult to be sure that the value of the capacity which theory assigns as necessary was the exact practical value necessary to make the time constant of one side equal to that of the other. Another somewhat similar arrangement would be as follows :—



A the transformer circuit.
T thick-wire coil of wattmeter.
F fine-wire coil of ditto.
R_1 inductive resistance in series with F.
R_2 non-inductive resistance equal to R_1.
E ,, ,, ,, F.
S_1 S_2 non-inductive shunts, equal in value.
C condenser.
G low-resistance differential galvanometer, with soft iron needle.

The fine-wire circuit of the wattmeter F is put in series with a condenser, C, and inductive resistance R_1, shunted by a non-inductive shunt S_1. It is possible by a certain relation of the inductances of R_1 and F, and the capacity C, to make the effective time constant of the R_1, F, C circuit zero for the periodicity employed. The value of S_1 requisite may be ascertained by joining this circuit in parallel through a differential soft iron needle galvanometer with another non-inductive circuit of equal resistance, and adjusting both shunts S_1 S_2 equally until the needle of the galvanometer remains at zero. The discussion of the conditions to be obtained are rather too long to give in full. I will discuss this arrangement in some subsequent "Notes on Alternate Currents."

The most direct means to render the wattmeter an instrument of precision when used on inductive circuits will be to obtain some simple means of rendering the time constant of the fine-wire circuit accurately zero, and then the correcting factor as given by Prof. Ayrton will be always unity, no matter how large the inductance of the circuit under measurement.—Yours, &c., J. A. FLEMING.

ALTERNATING-CURRENT TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am just now studying the question of transformers with respect to the practical details of construction, and should be glad of replies to the following queries. I have read everything that has appeared in the electrical papers (including Gisbert Kapp's last paper), also Kennedy's hand-book; but, as usual, have not found the slightest allusion to the most important points of all. Take, for example, the case of a parallel distribution at, say, 1,000 volts. It is required to wind a transformer to run on above circuit, and to give an output of 1,000 watts. Supposing its efficiency to be 100 per cent., the work done in the primary coil will, of course, be 1,000 watts, *i.e.*, 1,000 volts and 1 ampere. Now, if there were were no self-induction in the primary coil, and the iron core were removed, the resistance would have to be 1,000 ohms to allow 1 ampere to pass; but it is obvious that the resistance must be very much less than this, owing to the back E.M.F. set up by the reversal of magnetism in the core and self-induction of the coil. What I require to know is simply this—what must be approximately the resistance of the primary coil, so that when the secondary coil is giving its maximum safe output not more than one ampere shall pass in the primary circuit ? What is the proportion between the current which will be produced in the primary—1st, when the secondary circuit is open, and, 2nd, when the secondary circuit is short-circuited ? With regard to the core, what is approximately the difference in the efficiency of a transformer with an open magnetic circuit (as in an ordinary induction coil), and one in which the coils are completely surrounded with iron, as in all recent transformers ? There are plenty of other points which could be easily settled by anyone having the use of an alternating current and the necessary measuring instruments. I am sure the results of such experiments would be of great interest to many other readers of this paper besides myself. I thoroughly believe myself in the A.T. system of distribution as the only practical means of distribution for central station incandescent work. The grand mistake, and one which is nearly always made by the promoter of central station schemes, is that of putting in boiler-power which is used exclusively for electric lighting or power transmission. It is obvious that it is necessary to keep the machinery ready to meet any sudden demand for increased current, and this being the case, two or three times as much coal will be burnt as is actually paid for by the consumer, especially when a meter is used. It is practically impossible, therefore, to supply the current at a price which can compete with gas. The promoters find this out when too late, and too often resort to that curse of the electric light industry, the secondary battery (as at present constructed) as a supposed remedy. By working the boilers at full steam from dusk till dawn, and drawing off the surplus steam to drive air compressors or other machinery, which can be cut off one by one as the demand for current rises, it will be found that the direct-supply system can more than hold its own, even were

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secondary batteries as efficient and durable as the opponents of direct supply claim them to be.—Yours, &c.,

ELECTRICAL ENGINEER.

GLASS CONDENSERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your extract from the *Electro-technischer Centralblatt* in last week's issue, entitled "On a Glass Condenser," the author considers the result may be equally well explained on the theory of permeation of charge or on Kohlrauch's theory of polarised molecules. Doubtless some part of the effects observed may be due to the penetration of the charge into the dielectric, but the polarisation is so much greater than is usually shown by glass as to require some further explanation.

Will you allow me to suggest that the phenomena observed are due to the condenser being an accidental combination of secondary battery and condenser?

The plates of glass being somewhat porous and probably containing either moisture or some of the chemicals from which the silver coating of the plates were deposited.

The same excessive polarisation results are obtained with non-homogeneous insulators, in which a liquid conductor is incorporated. Gutta percha, for example, which is known to contain much water, behaves in this way, and so also does india-rubber, but to a much less extent.

The interposition of a more homogeneous insulating medium between the conductor and the mass of the dielectric reduces this absorption charge, and in condensers in which the dielectric is still more homogeneous, as when oil or air are employed the absorption effect disappears almost entirely.

The tests given show that the polarisation appeared to vanish at a low temperature. Probably this low temperature would coincide with the freezing point of the liquid electrolyte, with which I imagine the pores of the glass to be occupied and at which its chemical activity was suppressed.—Yours, &c.,

F. HIGGINS.

17, Cornhill, E.C., April 18th, 1888.

CONSTRUCTION OF RESISTANCE-COIL BOXES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the "Note" on the above subject in last week's issue, I have to thank Mr. Anthony for pointing out the necessity for having two connecting wires for each block in resistance boxes. He will find that I have said as much in the articles in question, the words used being, "There are two of these wires to each brass block, so that each coil is attached to its own individual pair of copper wires." Both wires are, however, not shown in the figure.—Yours, &c.,

April 14, 1888. H. D. WILKINSON.

[In connection with this subject it may perhaps be useful to remark that with bridges of the ordinary pattern in using coils of the lower denomination a still more serious error may arise, owing to the differences in the number of plug contacts which are required for different resistances. This source of error is reduced to a minimum in bridges of the dial pattern.—Ed. *E*.]

TELEPHONE INFRINGEMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The matters referred to being *sub judice*, I am unable to enter into any discussion with regard to the contents of Mr. John S. Sawrey's letter in your last issue.

I can only state that Mr. Sawyer's description of the construction of the Equitable Telephone Association's receivers attacked by the United Telephone Company is quite incorrect, and that the scope of the latter company's contentions is, as shown by documents in my possession, much wider than Mr. Sawrey apparently finds it convenient to assume.—Yours, &c.,

A. A. CAMPBELL SWINTON.

75, Queen Victoria-street, E.C., April 17th, 1888.

PHYSICAL SOCIETY.

"THE ELECTRIFICATION OF SOAP BUBBLES"

The experiments shown at the meeting of the Physical Society on the 14th inst., by Mr. Boys, on "Soap Bubbles," were exceedingly interesting and beautiful. They were designed chiefly to illustrate two points, the great difficulty with which two films can be made to unite except by the coalescence of drops of solution on their respective surfaces and the diffusion of various gases through such films. A very curious, and as yet unexplained, result obtained by the author was that the least trace of electrostatic attraction between two films was sufficient to cause their immediate coalescence.

A bubble could be forced through a wire ring of much smaller diameter than its own by the pressure of a film formed on another wire ring. A bubble could be blown inside another until the outer one was expanded to more than three times its original size by the pressure of the internal one, the outer one being obtained in a nearly cylindrical form with rounded ends to prevent contact between the lower portions which would have caused coalescence owing to contact between the two adherent drops of solution. When the inner bubble was thus pressing strongly against the outer one a large tuning fork was set in vibration in their immediate proximity, setting the films in violent vibration, but still no coalescence took place.

When, however, two bubbles resting on wire rings were brought into contact, and the smallest trace of electrification communicated to one of them, even if too small to be detected by any of the ordinary methods, coalescence at once took place.

In connection with this it is interesting to recall an experiment exhibited by Lord Rayleigh at the Royal Institution last year. Two jets were made to meet at right angles, and showed no tendency to coalescence; but this immediately took place if either of them had the slightest trace of electrification.

TELEGRAPHIC AND TELEPHONIC CHARGES: DEPUTATION TO THE POSTMASTER-GENERAL.

On Friday the Association of Chambers of Commerce waited upon Mr. Raikes with reference to the telephonic and telegraphic charges, Colonial postage, and telegraphic money orders. Sir A. Blackwood accompanied the Postmaster-General. Colonel Hill, Sir A. Rollit, Sir E. Birkbeck, Messrs. Maclean, Herbert Gladstone, Craig and Jacoby, and other members of Parliament were present.

Colonel HILL introduced the several subjects. With regard to telephonic communication, the Chambers considered that the present system, by which telephonic lines were in the hands of many competing companies, was not at all a desirable one. They felt that telephonic communication was a matter very much more considered than it was some time ago, and a greater desire existed for extending facilities for such communication; and in the opinion of the Chambers the big towns ought to be connected with each other, and that suitable "call" offices should be established in the towns, where people might avail themselves of the use of the telephone. They desired that the telephonic lines and the whole telephonic communication should be handed over to the Post Office. The transfer of the telegraphs to the Post Office had been very satisfactory, and they believed that the same result would follow from the taking over of the telephones. If this were done the Government could bring down the telephonic charges, and the largely increased business resulting would make it a paying concern. With regard to communication with lighthouses, they desired it on two grounds, viz., the saving of life and property and the convenience of navigation. As to the telegraphing of money orders, that would be a great boon.

Sir A. K. ROLLIT, M.P., said there was a very strong sentiment in reference to the cheapness of communication and the absence of telephone lines and in other ways that the country did not get the full benefit of the telephonic system. The prices for private wires charged by the Post Office were practically prohibitive. Some reductions had been made, but the scale of reduction had been very slight. With the surplus of the Post Office at about three millions there was plenty of room for liberality, especially as the resources of the Post Office were equal to the new demands which they were making.

Mr. BAYLEY (Plymouth), Mr. PLUMMER (Newcastle), Mr. WATER, and Mr. KENRIC MURRAY having spoken,

Mr. RAIKES, in reply, said that as to the question of telephones, he approached that subject with caution, owing to an imperfect report of his speech having made him say that it was the intention of the Government to acquire the telephone system of the country. He did not say anything which could fairly bear that interpretation. But if they were going to have a universal system, it

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was quite plain that it must be either in the hands of one universal company or it must be in the hands of the Government. He did not imagine that any of them would ask the Government to give a monopoly of telephones to any particular company, and therefore their wishes tended towards the acquisition of the telephones entirely by the Government. But certainly this was not the most favourable moment for taking up that question with a view to action. They were familiar with the circumstances of the existing telephone companies and associations; their patents gave them something like a practical monopoly, but there would come a time when the Government would be able to treat with them on better terms than at present. He quite admitted that the telephonic system had been cramped by the conditions under which it existed, and he should be glad if any change could be made which should be satisfactory to the public. Sir Albert Rollit had told them that the prices were prohibitive. He agreed with Sir Albert; and it had always seemed to him that the charges for additional convenience, either telephonic or telegraphic, were larger than he should wish that they were; and he thought a little gentle pressure on the part of the public upon those who were the paymasters of the State might have more effect than pressure brought to bear upon himself. With regard to lighthouses, that matter was entirely in the hands of the Board of Trade. As to the telegraphic money orders, the main objection of the Government was the large balances which it would be necessary to keep at the small post-offices, and that would be a great temptation to the small postmasters. He had, however, given directions for making an experiment at Birmingham and Brighton; and if the results were satisfactory he might be encouraged to go further. The various matters submitted to him were receiving the most careful attention of the Post Office.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.—TUESDAY, April 17.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 2) BILL.

The EARL OF CRAWFORD, on rising to move the second reading of this Bill, remarked that he did not intend to weary their lordships by going into the former discussions upon this subject, and that the Bill was rather more extended than any previous measure relating to electric lighting. He would, however, briefly explain the changes which he proposed to introduce into the law on this subject. Under the second clause of the Bill the persons who were known as undertakers, and who provided currents of electricity for the purpose of distribution to individuals within a certain area, would be permitted to make their arrangements with the local authority as a licensing authority without having to go to the enormous delay and expense of going to a central office for a provisional order and of having that order subsequently embodied in a special Act of Parliament. The cost of the provisional order system and the Parliamentary procedure consequent thereupon was undoubtedly very high, and in addition to that there was the grave objection that that course of action could only be taken during a certain portion of the year. Unless everything was not foreseen for the next six months no work practically could be proceeded with until a new provisional order was obtained. We had to go now into a very much larger question than was contemplated in 1882 when this Act became law. In addition to the method of procedure by license, provisional order, or special Act, the present Bill would enable the local authority to enter into an agreement with, and to grant permission to, the undertakers for their several works and purposes as set forth in this Bill. In the event of the local authority refusing, the Board of Trade would be authorised to step in and to say whether that refusal was a just and a right one or not. Clause 3 went into the question of the description of the supply, and proposed that it should be given only under certain rules to be laid down by the Board of Trade. The application of electricity for lighting purposes had been in use for six or seven years, and in consequence of the demand the Phœnix Insurance Company started in 1882 a printed set of rules for the guidance of persons who were using the electric light. By carefully following those rules accidents might, as far as possible, be avoided. The rules were first published in *The Times* in May, 1882. He had made it his business to inquire whether there was any additional risk placed upon buildings which were lighted by electricity or in which the electric light was employed. He was informed by the Phœnix Office that no extra premium was charged on buildings prepared for the reception of electricity under the rules they had drawn up, even though other modes of lighting were also used. In regard to the question of safety for life, he was informed by the Pelican Office that where a building was wired in accordance with the rules laid down by the fire insurance offices they considered that there was no greater danger to life than there would be in an ordinary dwelling house. Therefore he said that the Board of Trade in framing any rules for the guidance of undertakers ought to give great weight to the rules which had already obtained during so many years, and which were drawn up by those who were thoroughly acquainted with the subject. Clauses 4, 5, 6, and 7 of the Bill were practically taken from the Gas Act of 1847, which was incorporated in the Electric Lighting Act of 1882 as far as those clauses were concerned. Those clauses contained all that was necessary in regard to the powers to be given to undertakers in taking up streets in passing from one part of a town to another. Clause 7 gave the local authority the power in all cases to do the work of breaking up the streets and reinstating them. Clause 10 was intended to give a legal status to telephones, which were now doing such valuable service, and to protect them from all possible damage by an electric lighting undertaking. He also proposed that when the undertakers were not the local authority, but a company or private individuals, they should pay a certain sum per annum to the relief of the rates for the privilege of being allowed to use the streets. He would suggest that the sum so to be paid should be £20 a mile, and in Committee—if his Bill should go into Committee—he should be prepared to state the amount which that rate would realise if London were properly dealt with. Their lordships would be surprised to learn to what an extent the rates of London would be relieved if this were done. The Act of 1882 prescribed the periods within which the works of an electric lighting undertaking were to be finished. He would propose to leave that question to be settled between the local authority and the undertaking. The next thing was that within five years from the passing of the Act all cables or wires or mains for electricity should be placed underground. Clauses 16 to 23 he had adopted from the Gas Act of 1871, and they regulated for the instruction of inspectors the methods of testing and the supply of the current to the consumer. Clauses 24 to 27 were necessarily of a temporary character, as they related to the character and quality of the supply, which at present there was no instrument accurately to test. He hoped to be able to work out in the laboratory a means of "standardising" the measurement and the current. Clauses 38 to 44 dealt with measurements, and he hoped to induce the Government to make a small addition to the Weights and Measures Act for the purpose of putting technical meters on the same footing as gas meters. In dealing with the supply to be furnished to the general public he had followed the lines of the Gas Act, 1871, so that every householder within 25 yards of the distributing mains should have a right to a current of electricity, and the undertakers should be under similar obligations to those of gas companies. He had also given the undertakers, subject to certain conditions, the power of withdrawing the supply on account of the use of a dangerous or objectionable lamp. Clause 32, also following the Gas Act, gave a local authority power to require a supply if they were within 50 yards of a current. Clause 33 dealt with the question of penalties. He did not desire to invest the electric lighting companies with any permanent monopolies; all that he asked was that they should be placed in no worse position than they were in when they first entered into their contracts. He hoped that the Bill would now be read a second time, that a great industry which had been kept back for six years since the Act of 1882 was passed would have room to exercise their capital. He knew of his own knowledge that if the law were made somewhat on the lines of this Bill that in the course of six or eight months large sums of money would be thrown into the country, and employment provided for large numbers of working men. He believed that 40,000 men would speedily be employed in preparing these works and upon the business of electric lighting. In conclusion he would only add that, in preparing this Bill, he had kept himself entirely free from any bias in favour of the electric companies, and he had endeavoured to take a fair view of what was due to the local authorities and the gas companies. He had, in fact, tried not to be a partisan one way or the other, and he trusted that this Bill, the second reading of which he begged to move, would meet with the approval of their lordships as being fair and equitable (cheers).

LORD THURLOW said, while agreeing with much which had fallen from the noble earl, he did not find himself in a position to withdraw his Bill on this subject. It was only a large amelioration in the existing law which would set the large amount of capital ready for investment free. Ever since the Act of 1882 firms and companies of electric engineers and others interested in the subject had petitioned Parliament for such modifications in that Act as would remove those restrictions which, it was alleged, had the effect of crippling the progress of electric lighting, and in a petition which was presented to their lordships' House on Monday those gentlemen had expressed a view, which he shared, that a Bill so complex in its character as that of the noble earl's stood but a faint chance of finding acceptance, if not in this House, at any rate in the other House of Parliament. Having regard to the circumstances and to the subject matter, he had no hesitation in saying that the petition embodying that view was signed by as representative and influential a body of names as could be brought together. The second reason why he was unable to withdraw his Bill in favour of that of the noble earl was that it was too soon after the great Act of 1882 to revive the whole question. All that was wanted was a simple measure of relief to the companies, giving them a larger measure of time in which to recoup themselves for their original outlay, so that they should not be compelled against their will to charge their clients a prohibitive price for the electricity which they supplied. A measure of such proportions, dealing with public questions so complicated and important, ought, moreover, to be brought in on the advice of the Board of Trade, or some other Government department, in order to do complete justice to all the interests at stake. His third objection was that it legislated on many points of detail which should be left to be dealt with by provisional order according to the merits and requirements of each case. Lastly, with regard to the purchase clauses, he objected to the Bill that it did not recognise the absolute right which the local authority should have, in his opinion, to become the purchaser on fair terms of the undertaking of a private company supplying electric light within the area of such authority.

The EARL OF ONSLOW said that the speech of the noble marquis on the occasion of the second reading of his noble friend's Bill would have shown that the Government were sincerely desirous to do what they could to promote the extension of electric lighting; and if it had been certain that the Bill now before their lordships represented the feeling of those interested in promoting electric lighting in this country, it might have deserved a more attentive consideration. But, as had been just pointed

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out, a petition had been laid upon the table signed by a number of leading firms in the trade who would be most likely to apply to negotiate with the local authorities, and they were satisfied with the Bill of the noble lord opposite (Lord Thurlow). He might further say that since the Government consented to the second reading of the Bill of his noble friend opposite there had been a very large number of applications to the Board of Trade in the hope that the extension of time from 21 to 42 years would have the effect of inducing capitalists to embark money in these undertakings. This Bill proposed to make an important change in the existing law. Hitherto Parliament had declined to allow companies promoted, whether for purposes of electric lighting, gas supply, or tramways, to make their bargains for themselves without the supervision and consent of Parliament. But this Bill proposed to abolish the provisional order altogether, and the noble lord only proposed to do it in the case of the electric lighting companies. There were, he admitted, proposals in the Bill which were commendable. No doubt it would be a great advantage to secure, within a reasonable period, that those overhead wires which were a danger and disfigurement to the metropolis should be laid underground. In the Bill of the noble earl there was no provision for any penalty upon any company which failed to carry out the removal of wires. It was impossible to discuss in Committee of the whole House all the complicated and technical proposals of this Bill. Although it was true that many Committees had sat to consider this question of electric lighting, still they had not dealt with all the technical and difficult questions set out in this Bill. As he had said before, the Government were anxious to do all that they could to encourage the investment of capital in electric lighting, and although he had stated several grave objections to the Bill of the noble earl, he did not wish to throw any discouragement in the way of the increase of electric lighting. He thought, therefore, that this Bill might be allowed to go through its second reading, and then he would suggest to the noble earl that it should be referred to a Select Committee, and that on the report of that Select Committee the next stage of the Bill should be taken.

LORD HERSCHELL was glad to hear that the noble earl who had just spoken did not intend to oppose the second reading of the Bill now before them, because it involved questions of considerable interest and importance, and if some alteration were made in it it would not be inconsistent with the passing of the other Bill dealing with the subject which had received its second reading. He would regret extremely, however, if this Bill were made a ground for postponing the progress of the Bill to which he had referred, because the Bill of the noble earl no doubt raised very complicated questions which would mean minute discussion and examination, and he was anxious lest the effect would be to hang up this question to an indefinite period and prevent any legislation on the subject passing at any early date. With regard to the petitions which had been referred to, he believed that they were directed towards supporting the scheme which was already in progress rather than to opposing the Bill of the noble earl. There was no doubt that the Act of 1882, with regard to the terms of purchase, needed amendment. It was not the case that whether the terms were onerous or not was a matter affecting only the promoters and the local authority; apart from the question of whether they could make the terms such as to induce capitalists to put money into electric lighting, he thought that the public had a distinct interest in seeing that the terms were not too onerous, as the undertakers would seek to recoup themselves by charging more than they otherwise need for the electric light. That meant that the present generation was to pay more than they otherwise need for the electric light in order that the next generation might get it for less than they ought. He hoped, therefore, that the measure of his noble friend, which had already been read a second time, would be allowed to proceed. At the same time, he hoped that the Bill of the noble earl would be read a second time. Owing to its complicated character, he thought there was little chance of its passing through the other House this Session.

The Bill was then read a second time.

COMPANIES' MEETINGS & REPORTS.

The Electrical Power Storage Company (Limited).

The seventh ordinary general meeting of the shareholders in this Company took place on the 19th inst. at Winchester House, Old Broad-street, under the presidency of Sir Daniel Cooper, Bart., K.C.M.G.

The SECRETARY (Mr. Holland Dell) having read the notice convening the meeting,

The CHAIRMAN said: In addressing some observations to you before moving the adoption of the Directors' report and statement of accounts, I have first to notice that the volume of business was not as great last year as we expected, but I am glad to say that already this year a substantial increase has taken place. Our business is of a more solid character than in the past, and we direct our chief efforts to increasing the manufacturing output, as our object is not so much now to compete for large public lighting contracts. We attach, however, great importance to our installation work, and consider it to be most essential that both in the metropolis and throughout the country we should demonstrate to the public and to the electrical trade those methods and arrangements which have been adopted by our engineering department as best suited to the development and successful use of E.P.S. storage batteries as applied to electric lighting. As regards the results of the working of the year the gross profit is, as shown in the accounts, £11,875. 1s. In addition to the ordinary general expenses of management, debenture interest, &c., and the numerous charges incidental to a special business such as this Company carries on, we have allowed a very liberal provision, £1,569. 1s. 7d., for depreciation of plant and machinery, and for estimated doubtful debts, and have considered it correct to write off £1,000 from the patents account in connection with the French patents, which are now being worked in France under a satisfactory arrangement with the Company, and this sum is also deducted from the gross profit. Apart from these items it will be seen that the business about paid its way, but as we have a large balance to the credit of profit and loss we put £4,000 to a reserve fund and carry forward the balance of £6,793. 6s. 11d. We think you will consider that this policy will tend to strengthen the position of the Company, and that you will therefore approve it. The business, though unavoidably of a fluctuating nature, necessitates our keeping a staff ready and competent to deal with whatever demands may arise. Our principal branch of electrical work—the construction and working of storage batteries and their appliances—is comparatively so young an industry that we have to educate and train a staff for ourselves. I mention this in part explanation of the growth of our standing charges. There has been an increase in royalties for the past year, but I look for a much greater increase during the current year, as the result of the arrangements now completed on the Continent. The amount of patent charges, &c., of £1,080. 12s. 5d., includes expenses in connection with preparing for the patent suits alluded to in the Directors' report. The Directors are pressing on their suit against the Union Electrical Power and Light Company. Our business suffered much injury last year from the public statements of the Union Company of the superiority of their battery to the E.P.S. battery. We are always liable to sustain temporary damage by reason of so-called improved secondary batteries being brought to the notice of the public, and thus for a time shaking confidence, and causing would-be purchasers to hesitate and delay until they see what the new thing is. The general public are obviously unable to put the true value on these statements, and it requires time and labour to disprove even the wildest assertions which are put forward. We know of other batteries, some of which in due course, I suppose, will be heralded forth as marvels of excellence, but our shareholders may rest assured that these have not escaped the attention of the Directors, and these batteries, should they ever struggle into notice, will, like all the others before them, speedily disappear. The Directors considered it advisable to purchase an interest in certain outside patents, and it is necessary to take out others from time to time to cover points which may suggest themselves in the course of practical work, and these outlays have increased the amount of the patents account. Among other patents taken out are two of Mr. Sellon's, who, as you are aware, is always at work for the benefit of the Company, and who carries out all his experimental work at his own personal expense. These patents are for new forms and arrangements of batteries which, especially in the case of large central lighting stations, may prove of considerable future value. A brief record of the interesting and novel applications of E.P.S. batteries during the past year has been given in the Directors' report, and I need not here repeat them. I would, however, draw your attention to the importance for the Company of the question of central station lighting by storage batteries as against alternating-current transformers, and to the warm discussions and interest these rival systems are now exciting. The pamphlet issued by this Company on the subject was the result of much careful preparation, and is well worthy of perusal. Our engineer, Mr. King, continues his work in this particular direction. In motive power, the new electrical launch which made its public appearance at the Oxford and Cambridge Boat Race, and of which you may have read favourable notices in the electrical and other papers, embodies our latest improvements in batteries and motors, and is also fitted with special starting and reversing gear which is all quite novel. The efficiency of the motor averages 88 per cent. The best speed yet attained has been 11 miles an hour on a rather slow tide. The launch is 30ft. long, 6ft. 6in. beam, and 3ft. 6in. draught. At half speed the boat will go for 18 hours, and it is obvious that a noiseless boat of this size and speed will be useful for a variety of purposes, both for harbour and river work. The shareholders will note that the Directors are fully alive to the necessity of keeping abreast of all inventions which may conduce to the use of storage batteries, and attention is therefore being given to continuous current transformers in connection with storage batteries. We did a good deal of temporary lighting during the Jubilee rejoicings, and among our customers are His Royal Highness the Prince of Wales, the Duke of Leeds, Lord Rosebery, Viscount Stern, Mrs. Mackay, and many others. This Company lit the hall of the Middle Temple on the occasion of the dinner to His Royal Highness the Treasurer. Among the permanent installations referred to in the report may be mentioned the Bank of New Zealand, the hall of the Leathersellers' Company, the extension of the lighting at Lloyd's and at the Brazilian Bank, at Barclay, Bevan, Tritton and Co.'s; also the lighting at Naylor, Benzon and Co.'s, William Joynson and Sons, in Kent; and among private residences, that of Harry Taylor, Esq., Abraham Dixon, Esq., T. A. De la Rue, Esq, G. Newnes, Esq., M.P., and others. As regards the immediate improvements in our manufactures, I must allude to the latest form of E.P.S. battery, known as "1888" type, which has received commendation from all classes of engineers and others, as having successfully removed difficulties and objections to which some of the former types were exposed. Much credit is due to Mr. King and our electrical staff for elaborating this new type of E.P.S. battery. I am very glad to say that we have now no litigation on the Continent. Our Managing Director, Mr. Courtenay, has been obliged to make frequent trips to various parts of Europe, and has at last succeeded in terminating the law suits, and in making satisfactory arrangements with our adversaries, and, as I have already stated, we look for a considerable addition to our revenue from our Continental interests. Our friends in America, the Electrical Accumulator Company, are busily engaged in manufacturing batteries, and in developing the immense field for business before them, and are also taking steps to establish in the Courts the control for the Faure,

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Swan, Sellon, and other patents they possess of the secondary battery business in the United States; and there is no one who is better fitted by his previous training to conduct that contest to a winning result than Mr. Vail, the president of the American Company. I will now conclude by stating my conviction that at no time were the prospects more favourable to the electrical business generally, and no Company is more likely to profit by its revival than we are. I beg leave to move the adoption of the report and accounts, and to call on Mr. Sellon to second the resolution.

The VICE-CHAIRMAN (Mr. J. Scudamore Sellon): I beg to second the resolution. I am free to confess that the accounts may appear somewhat disappointing to some of you. Some months ago, having in view the good work in hand and prospective orders of exceptional magnitude, my unhesitating forecast would have been that at the present moment we should have been in a position to distribute a very satisfactory dividend. What, then, are the causes of the present non-dividend position, which has perhaps tried the patience of some of you? The Chairman has lightly touched on them, and I would wish to emphasise his remarks, so that you may understand why we have good reason to look upon this position as only temporary, and be in no way discouraged by the unforeseen and exceptional obstacles which we have had lately to encounter. The first deterrent cause which the Chairman mentioned is the appearance from time to time of announcements of some new battery which is, of course, to eclipse all others, generally accompanied by the most reckless statements as to greater economy, durability, and general advantage. Such statements mislead the uninitiated, who, knowing the secondary battery is one of the important items of an installation, naturally, as the Chairman has said, hesitate to incur expenditure for any existing forms, which they are led to suspect will be immediately superseded. The stop thus put to electric lighting was incalculable, and it has been more especially marked during the last year; but this class of obstruction is now, we may hope, thoroughly thrashed out. You may, perhaps, remember that at our last meeting I took occasion to refer to a prospectus put forward about that time in which promises were held out for supplying the necessary store of energy by delivering charged cells from house to house and replacing them when required; in fact, the millennium of a perfect electric light was held out to the happy customers, who were to have no trouble and only to be subject to a low payment for the amount of electricity consumed. It is impossible to estimate the amount of injury done to your interests by these and similar wild and unjustifiable propositions, and I ask you whether my criticisms, which were much called in question at the time, were not fully justified? A year has passed, and not one single item of the enticing programme put forward with such a flourish of trumpets, and which for the time almost stopped our business, has been fulfilled. This is one example of the difficulties which needlessly have beset our path. Another, which, in my opinion, may be fraught with far more serious consequences to the public, is of a very different, and, for the moment, of a more important character; but it is being grappled with, and will assuredly prove but temporary. I alludd to the alternating-current transformer craze, for I can call it nothing else. There is, however, one satisfactory feature even in this. It evidences the fact that the public have at last realised that the electric light is a necessity of civilisation. They must and will have it, and they are now ready to avail themselves for the moment of whatever is brought under their notice, notwithstanding its shortcomings and defects. This is a great point gained, because we may feel certain that they will not be contented, once having realised its advantages, to do without it; and we may also feel quite sure that eventually no system which does not afford the highest attainable security against any possible danger or chance of extinction will be adopted. It is generally felt that, sooner or later, the lighting of theatres will be taken under the control of the Legislature. Now, is it likely that any system will be sanctioned, or even tolerated, which does not safeguard the public against possible chance of extinction of the light, which, in the absence of the storage system, may occur at any moment from the most trifling accident to the machinery in motion, to the transformer, or, in the case of overhead wires, to the leads? Conceive for a moment the effect of a sudden storm upon the ramifications of the telegraph and telephone wires crossed and recrossed by the electric light leads, carrying powerful alternating currents. Besides the incalculable damage that may be done to telegraph and telephone systems, every theatre and every public resort in London, if thus supplied, might be accidentally plunged into darkness, and catastrophes would arise as serious, though not, perhaps, so harrowing, as those which of late unhappily so often occurred through fires. I think we must accept it as being beyond doubt that reliable continuity of the electric light is essential, and that it can only be secured by the use of storage batteries. This being a condition indispensable both for the progress and the success of electric lighting their extended and ultimately universal use must be considered a certainty. This being so, you may realise what position your property, covering as it does the whole field of electrical storage, holds in connection with electric lighting, which is only, you may say, just now starting into real vitality. The distribution of electricity from centres furnished with storage batteries, is now engaging the attention of our foremost electricians, and its practical accomplishment is well within view. The objection raised by some that such accumulator depots are impracticable by reason of the multiplicity of the cells is absurd. Their ideas evidently do not go beyond the present baby type of the cell in general use, which is fairly meeting the demand up to the present time, whereas the local station accumulators of the future will consist of cells containing plates of a dimension and capacity hitherto unknown, the manipulation and working of which, of whatever size, are rendered not only possible, but free from any difficulty whatever with the improved form recently patented. I think it is hardly too much to say that from the date of the first of such centres being successfully at work the first stroke in the death-knell of the dangerous and uncertain alternating-current transformer system will be sounded. The finishing stroke will probably be the introduction of continuous-current transformers working in conjunction with secondary batteries, a system which is beginning to attract much attention, and which in the opinion of many of our best electrical experts will carry all before it. We seem thus to be on the eve of what may be called the battle of the systems. I have no fear as to the result, for independently of any question of £. s. d., the winning side must be that which proves its claim to reliability and safety, which means only those systems that adopt storage batteries. To sum up shortly the position, we have now at great cost and labour established the secondary battery on a firm basis as an indispensable and reliable factor in electric lighting. We have, as the Chairman stated, both at home and abroad secured the recognition of our rights as possessors of all the practical and useful patents in connection with this most important branch of electric work. We have, after long training, an excellent, and I think I may say a devoted staff, superintended by one whose skill and experience in our special line are very great, and who is working heart and soul in your interests, and one in whom we are thankful to feel in these degenerate days we can place perfect confidence. I allude to our electrical engineer, Mr. King. Under this combination of favourable circumstances and conditions, and having in view the development of electric work now going on by leaps and bounds, I think you must agree with me that our prospects are as good as could be reasonably hoped for. I hope that the report and accounts will be accepted, and that we may have a most successful year.

A short discussion followed, in which Messrs. Muggeridge, W. France, and J. H. Ainsworth took part.

The MANAGING DIRECTOR (Mr. John Irving Courtenay), in reply, said: I will take the remarks of the last shareholder first. You will observe that the £4,000 is not a cash balance; it is undivided net profit or book account, and therefore it is not in the form of cash, but it is to our credit. We distribute it by putting £4,000 to the reserve fund. It is not like available cash at the bank. We carry forward £6,000, which is undivided net profit. We should be very glad if it were in cash. I do not say that in that case we should have paid off the long-suffering Directors. We should be very glad to have the cash in the business, and I dare say the Directors would wait a little longer. What this Company really wants is to have large cash balances to meet our competitors and to meet the large business coming in. The Directors will be happy to consider the suggestion as to presenting some kind of interim report. As regards the gentleman who asked whether the amount owing to the Company is good, you will observe that we state "by current accounts due to the Company after providing for bad and doubtful debts." We have gone through these accounts carefully and we believe that that amount is good. I have no reason to suppose that our estimates for this year will not hold good. In regard to the question of Mr. Muggeridge, the item of £5,830 is larger than it was last year, because we have put into that item the Directors' fees, which are the same as last year, £1,500; but I may take the liberty of stating that they have not been paid any fees for the last nine months. The item is also larger than last year partly through the increase of the staff, and partly also owing to the increase in the salaries of some officers who have been with us for some time. As explained in the Chairman's speech, we are obliged to keep a permanent staff. We are compelled to train them. We do not discharge people at a moment's notice because business is slack. We would not do that, and we cannot do it. It would be very false economy for this Company to train up a staff, as we must do, from the special nature of the business, and then because the business is slack for a month or so discharge any of them. If the shareholders wish me to give any further explanation I shall be happy to do so before making some remarks on some other points; but if no one wishes to say anything else I would desire to call attention to this battle we are engaged in of batteries, &c., to one of the most salient features of our E.P.S. battery, and the point I wish to draw special attention to for the moment is the durability of the article we produce—the life of the E.P.S. storage battery. I have had lately a most remarkable instance of that. When I was in Vienna last January, I had the opportunity, owing to the courtesy of the representatives and electrical staff of the Imperial Continental Gas Association, to inspect the arrangements for the lighting of the Opera House there, in which you are aware this Company was associated. In that building there are 1,390 storage batteries of the E.P.S. type. That lighting is carried out to the entire satisfaction of the authorities. It is carried out upon the storage system with E.P.S. batteries. When I was there the cells were all, without exception, in the most excellent condition. I will now go on to allude to the most striking instance that has come under my knowledge, and I will give it as it was reported to me. The central lighting station in Vienna, belonging to the Imperial Continental Gas Association, is lighted from two batteries of E.P.S. cells. There are 53 cells in each battery. Each cell is of our largest size, containing 31 plates, so we have there 106 cells, or a total number of plates of 3,286. Those batteries have been in daily use for one year and three months, and what do you think has been the percentage of the renewals, or how many plates do you think have been renewed from these 3,286 during that period of constant use? One peroxide plate—or, as it is commonly called, positive plate—one out of the whole of that number. When we talk of the life of storage batteries I do not say that is the average, but there is evidence of independent people who have bought and paid for these plates, worked under careful and intelligent supervision. I ask is not that a commercial article? Are we not justified in practically, as we do, guaranteeing our goods at fair moderate rates? I desire to call public attention to this, because I was not aware of what had taken place in Vienna until I was there myself. I am sure it is a feature that shareholders will be glad to learn that we have now arrived at a com-

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mercial stage. There is one other point that no shareholder has called attention to, and perhaps it is not wise for a Director to call attention to it as the shareholders have not done so. However, people say: "You are always taking out patents." So we are, and I wish this to go forth, that when we take out patents for improvements in batteries, covering points which have occurred to our people in practical use, we think that that money is well laid out. Mr. Sellon and the Chairman have alluded to it. When you take out a patent, as we have done latterly, for what we call our 1888 type, it is protected in this and other countries. It has this effect, it practically lengthens the life of the original or basic patents, and therefore, if so many years have gone by of your original patents, still you can keep them alive by getting out from time to time patents that you believe will be valuable and that are essential to the working of these patents. That is the policy we have adopted, and I hope the shareholders will recognise that it is judicious expenditure. I would only repeat what has been said by the Chairman, that if anything like a tithe of the inquiries that pour into our office all day come to business, we shall show this year a very different statement to what we have presented to-day. I believe now it is entirely a question of orders. We are dependent on the public and trade for orders. We are ready for the business, and we can make money when we get orders; but I desire to say, do not reproach me or the Directors next year if our expectations are not realised. We can only judge by what we see, and certainly never since I have been connected with the Company have I seen so much interest displayed and so many inquiries coming in from the country and all parts abroad, as at the present moment.—In reply to Mr. FRENCH, he added: The batteries in Vienna were manufactured at our Millwall works, sent out there, and erected by members of our staff specially sent out for the purpose. We should not, however, do that in future, because we have granted licenses to the Anglo-Brush Company, and they will be manufactured by that company's licencees under our patents, and they will pay us a royalty.

The CHAIRMAN then put the motion, and declared it carried unanimously. He afterwards proposed the re-election of the retiring Directors, Mr. Frederick Green and Mr. Sellon.

General PENNEY seconded the motion.

The CHAIRMAN: Before putting it I may say as Chairman of the Company that we may not always agree in opinion, but we work very cordially together for the interests of the Company, and I do not think there are five gentlemen in the City of London acting as Directors who give more time and attention to any Company.

The resolution was carried unanimously.

On the motion of Mr. HEYWOOD, seconded by Mr. FRANCE, the auditors, Messrs. Deloitte, Dever, Griffiths and Co., were re-elected, and the meeting terminated in the usual way.

Montevidean and Brazilian Telegraph Company (Limited).

The ordinary general meeting of the shareholders in this Company took place at the offices, 2, Tokenhouse-buildings, on the 16th inst., under the presidency of Dr. Charles Cameron, M.P.

The report of the Directors for the year ended December 31 last stated that the percentage of gross revenue receivable from the Western and Brazilian Company shows a slight increase, being £2,508, as compared with £2,370 in 1886. The Directors had hoped from the improved condition of trade with South America that they would have been able to report a more favourable result to the shareholders. They were glad to observe that, so far as could be judged from the published returns of the Western and Brazilian Telegraph Company, there appeared some prospect of a greater improvement in the traffic during the current year. The shareholders would remember that the debentures issued in 1876 were made redeemable on the 1st of July, 1896. There being a balance of £10,280 still unredeemed, it would be necessary to set aside annually a larger sum for the purpose of redemption than hitherto, and the Directors therefore propose to appropriate £1,000 for that purpose for the year 1887. That would leave a balance of £474 available for division. They recommended the payment of a dividend at the rate of 1s. per share on the Preference shares, which would absorb £415, leaving a balance of £58 to be carried forward to next account. They regretted to inform the shareholders that Sir Thomas Gore Browne, K.C.M.G., C.B., who so long occupied the position of Chairman of the Company, died in April, 1887. Mr. James Joicey, M.P. (whose interest in the Company as a shareholder was larger than that of any other gentleman), was appointed a Director of the Company, to fill the vacancy left by the death of Sir Thomas Gore Browne.

On the motion of the CHAIRMAN, seconded by Lieut.-Colonel G. W. MACAULEY, the report was adopted; and subsequently the retiring director, Dr. Cameron, M.P., and the auditor, Mr. W. S. Ogle, were re-elected.

The Eastern Extension, Australasia, and China Telegraph Company (Limited).

Report and accounts of the Directors for the half-year ended 31st December, 1887, to be submitted to the twenty-ninth ordinary general meeting on the 25th inst., at 2 o'clock:—

The gross receipts, inclusive of Government subsidies, have amounted to £232,660. 0s. 11d., against £216,956. 2s. 8d. for the corresponding half year of 1886.

The working and other expenses, including £22,730. 1s. 6d. for cost of repairs to cables and expenses of ships, absorb £69,570. 16s. 5d., against £80,066. 10s. 11d. for the corresponding period of 1886, leaving a balance of £163,089. 4s. 6d. From this is deducted £3,605. 3s. 10d. for income tax, and £41,595 for interest on debentures and contributions to sinking funds, leaving £117,889. 0s. 8d. as the net profit for the half year, which, with £35,162. 4s. 9d. brought forward from the previous half year, shows an available balance of £153,051. 5s. 5d.

One quarterly interim dividend of 1¼ per cent. has been paid for the half year, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the first half year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 3s. per share, or 1½ per cent., making a total distribution of 6½ per cent. for the year 1887. The balance of £53,051. 5s. 5d. has been carried to the general reserve fund, which, after being debited with the cost of the further partial renewal of the Singapore-Saigon and Penang-Rangoon cables, amounting to £22,758. 15s., now stands at £620,095. 13s. 6d.

In pursuance of the conditions upon which the issue was made, 113 of the Company's 5 per cent. debentures of 1880 were drawn by lot on the 16th ult., for payment at par on the 1st May prox.

276 of the Company's 5 per cent. Australian Government subsidy debentures were also drawn on the 9th inst., for payment at par on the 1st July next.

The Company's maintenance ships have been employed on various cable repairs during the half year; but no interruptions of a serious nature have occurred.

The Government of New Zealand having declined to ask the Parliament for sanction to renew the New Zealand cable subsidy, the tariff for ordinary inter-colonial telegrams was raised on the 1st January last from 6s. to 8s. 6d. per ten words. A cheap rate has, however, been granted for news telegrams between New Zealand and Australia, which appears to be generally appreciated.

A further inter-colonial conference was held at Sydney in January, when the proposals submitted by the Company for reduced tariffs between Europe and the Australasian Colonies, based upon a colonial guarantee or subsidy, were discussed, and resolutions were come to that consideration should be given to the said proposals by the various colonies, and that each colony should contribute towards the existing and future cable subsidies in proportion to population.

Your Directors have to record with deep regret the sudden death on the 16th November last of their esteemed colleague Sir William McArthur, K.C.M.G., who had been connected with the Company since its formation.

Under the powers given to them by the Articles of Association they have elected John Denison Pender, Esq., to fill the vacancy thus occasioned.

In accordance with the Articles of Association John Denison Pender, Esq., and the Most Hon. the Marquis of Tweeddale retire by rotation, and offer themselves for re-election.

The retiring auditors, Mr. Henry Dever and Messrs. Quilter, Welton and Co., also offer themselves for re-election.

Reuter's Telegram Company (Limited).

Report to be presented at the twenty-fourth ordinary general meeting of the shareholders, to be held at the Company's offices, 24, Old Jewry, London, at noon on Wednesday, the 25th April, 1888:—

The Directors beg to report that the net profits for the year ending 31st December last, after payment of current charges and deducting rebate on unexpired subscriptions, amount to £4,241. 16s. 2d., including £186. 17s. 4d. brought forward from the last account.

An interim dividend of 2½ per cent. was paid in October last, and the Directors now declare a further dividend of 2½ per cent., making a total distribution, free of income-tax, of 5 per cent. for the year. This will absorb £3,680. 8s. 3d., and after adding £500 to the reserve fund, there will remain a balance of £61. 7s. 11d. to be carried forward.

In conformity with the Articles of Association, Baron de Reuter retires from the Direction, but offers himself for re-election.

The Auditors, Messrs. Quilter, Welton and Co., also offer themselves for re-election.

The dividend warrants will be payable on the 28th inst.

The Indo-European Telegraph Company (Limited).

Report of the Directors for the year ended 31st December, 1887, to be presented to the 21st ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, E.C., on Monday, the 30th inst., at 12 noon.

The Company's revenue from all sources for 1887 amounted to £104,290. 18s. 3d., as compared with £104,583. 0s. 7d. for 1886, showing a decrease of £292. 2s. 4d. The expenses were—on commercial and general account, £26,274. 7s. 4d., on maintenance account, £22,346 7s. 11d., including £256. 5s. 9d. paid to the Russian Government; total, £48,620. 15s. 3d., as against £50,773. 7s. 8d., a decrease of £2,152 12s. 5d. Deducting the above expenses, taking credit for £1,093. 6s. 7d. brought over from 1886, and debiting income tax, there remains the sum of £55,194. 15s. 1d. From this amount £10,000 has been placed to reserve, and that sum, together with £10,625, amount of interim dividend, have to be deducted, leaving a balance of £34,569. 15s. 1d.

The Directors now propose the declaration of a dividend for the last six months of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year, carrying forward £2,694. 15s. 1d. to the credit of 1888.

The falling off in the revenues derived from Indian messages remarked upon in 1886, has continued during 1887, but fortunately has been made up by other sources of traffic.

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Last November the Company applied the duplex system to work either of the two circuits between London and Emden; the arrangement has given very satisfactory results, and the cost of its introduction is included under the head of maintenance expenses.

Mr. C. Holland has joined the Board. The following Directors retire by rotation, and offer themselves for re-election:—H. Weaver, Esq., and A. Delbrück, Esq. The auditors, Messrs. C. F. Kemp, Ford and Co., public accountants, retire and offer themselves for re-election.

Societa Generale Italiana di Elettricita (Sistema Edison).

The Società Generale Italiana di Elettricità (Sistema Edison), operating the Edison patents in Italy, has just declared a dividend of 4 per cent. for the year 1887. The total receipts for the year were £30,493, of which £22,585 represent the income from the Milan Central Station, and £6,517. 10s. from isolated plants. The total expenses were £24,853, including £5,021 charged to depreciation account and sinking fund, leaving a net profit of £5,294, of which £4,800 will be distributed as dividends, and £494 carried forward as reserve.

The total number of lamps supplied from the Milan Station on the 31st Dec., 1887, was 11,010 incandescent lamps and 218 arc lamps, an increase over the preceding year of 1,470 incandescent and 64 arc lamps.

Seven theatres in Milan are now being lighted from the Central Station, the introduction of the Zipernowsky-Déri transformer system having permitted the extension to outlying theatres. The continued improvement in the financial results beginning with a dividend of 1½ per cent. in 1885, 2½ per cent. in 1886, and 4 per cent. for 1887, besides putting aside a large amount for depreciation (a total to date of £16,600), would seem to be full of promise for the future.

The Pilsen-Joel and General Electric Lighting Company (Limited).

Report of the Committee of Investigation appointed by resolution of shareholders at an extraordinary general meeting, held on the 13th March, 1888, to investigate the statements contained in the Directors' notice, dated 3rd March, 1888, convening such meeting, and to confer with the Directors, and to report thereon, and generally upon the business of the Company:—

The statement in the Directors' notice, dated 3rd March, 1888, that the amount of the working capital of the Company amounts to but £7,093, is taken from the last report and balance-sheet issued on the 10th November, 1887.

This sum of £7,093 is made up in such balance-sheet of the items of:—

Cash (including £2,986. 6s. Consols)			£3,037 9 0
Stock, plant, stores, &c.			3,874 0 11
and the difference between			
	Debtors to the Company	£966 3 11	
and	Creditors of the Company	784 13 5	
			181 10 6
			£7,093 0 5

As to the above item of cash, this has practically disappeared, as the whole of the Consols have been sold out, and the proceeds expended by the Directors, and the cash at the bankers at the commencement of this investigation was the sum of £140. 17s. 6d. only.

As to the item of stock valued at £3,874. 0s. 11d., this is the Directors' estimate of the value of the whole of the stock, plant, and stores, &c., of the Company.

As the three installations of the Company alone, at which a part only of such stock, plant, stores, &c., are employed, were earning, as stated in the last balance-sheet, a yearly rent of £3,485. 0s. 6d., and are now stated to be producing a gross yearly income to the Company of £5,000, it has been considered necessary to check this estimate of £3,874. 0s. 11d. by taking stock of the whole of the existing stock, plant, stores, &c., of the Company, and this has been very carefully done, with the following results, which it has appeared convenient to classify as under:—

——	Producing per annum.	Original cost to Company	Directors' Valuation.	Present Valuation.
Stock, &c., at Bethnal Green Installation	£1,200 0 0	£2,158 10 11	£416 14 7	£1,482 5 7
Stock, &c., Whetstone Park Installation	1,558 0 0	4,564 0 0	900 18 0	4,500 0 0
Directors' estimate of additions since June, 1887	—	—	2,328 5 11	
Stock, &c., at Stanhope-Street Installation	1,156 13 4	2,116 14 3	1,193 19 0	1,819 1 9
Stock, plant, stores, &c., at Stanhope-street Factory	—	3,413 19 6	1,022 0 0	2,093 9 0
Stock at Agents' and on Hire	—	—	340 9 1	340 9 1
	£3,914 13 4	£12,653 4 8	£6,202 6 7	£10,235 5 5

There has been great difficulty in arriving at the above figures in consequence of the unsatisfactory mode in which the books of the Company have been kept. There has been no stock ledger and no store ledger kept since 1884. There has been no stock book kept since 1884, except that the stock list of 1887 has been copied into a book. But the stock lists and valuations, it is stated by the secretary, have been kept separately for each of the years 1884, 1885 and 1886, and he states that such stock lists and valuations for the years 1884 and 1885 cannot be found, and they have not been produced.

It has therefore not been possible to trace or account for the stock from the year 1884, which in the balance-sheet of that year was then valued by the Directors at the aggregate sum of £29,876. 8s. 4d.

It is presumed that the shareholders do not desire to have in this report the details (which are very intricate and elaborate and can be supplied if desired), but only the results of the investigation, and in obtaining the results which are here presented to them every care has been given to make all due allowances for wear and tear and other circumstances of depreciation.

Having regard to all such considerations the value of the now existing stock, plant, stores, &c., of the Company is believed to be the above sum of £10,235. 5s. 5d.

In examining the valuation of such stock made by the Directors, it has been found that the stock, &c., has been most seriously under-valued. For example—a large number of Pilsen arc lamps in perfect order and in full working at installations, and each earning £20 yearly and upwards for the Company, figure in the Directors' valuation for 5s. 9d. each. The list price of such lamps is £12 each. The glass globes cost 10s. each. If sold by auction these lamps realise from £5 to £7 each, and the mere value of the metal if broken up and sold as scrap is 5s. 2d.

The sum of £3,874. 0s. 11d. fixed by the Directors as the value of the stock was arrived at by valuation in June, 1887, and there has been since that date certain additions to such stock, but Consols have been sold out by the Directors in the years 1887-8 which have realised £4,769. 7s. 5d.

In conference with the Directors as to the mode in which this sum has been disposed of, the only explanation given was that it had been spent upon the business of the Company, as would appear by the balance-sheet to June, 1887, and by the cash book.

To enable the shareholders to determine how far this explanation is satisfactory it has been considered necessary to prepare an analysis of the cash book, and in order that the years in which such a sum of Consols was expended may be compared by them with the years in which no Consols have been expended the analysis has been carried back to the year 1884, and accompanies this report.

The analysis is strictly compiled from the Company's cash book, and the attention of the shareholders should be directed (amongst other things) to the fact that although the income received by the Company from "Sales of Plant, &c.," has enormously decreased, the outgoings for "Rent, Rates and Taxes, Purchases of Stock, &c.," and "Wages" have varied but little comparatively. Also, that in one year £1,092. 11s. 1d. was expended in law costs, while the largest dividend paid in any year is £821. 18s. 8d. Also, that a sum of £2,500 appears in the cash book as a loan to "Ellis and Co.," and in conference with the Directors this is explained by them as having been lent to those gentlemen by the Directors with the object of obtaining 3 or 4 per cent. interest from them.

This lending of the money of the Company by the Directors to individual appears to be wholly irregular and unauthorised by the Articles of Association, and, moreover, upon investigation by the committee it is found that it was lent at an interest of 1¼ per cent. per annum only.

There also appears an item of "Contract for running new main Holborn £193. 19s. 4d.," and this was found upon investigation to be a payment to another firm of electrical engineers to run electrical wires to the Company's installations. This would seem to be peculiarly work proper to be done by the Company's own workmen instead of employing another firm to do it at a profit. In conference with the Directors, their explanation of this matter was that they thought it would be advisable, and was the best course in their opinion.

As to the statement in the Directors' notice that the item of £25,190 for goodwill and patent rights should no longer be maintained at that figure, and their intention of reducing it to £527, in conference with the Directors the following were the reasons given by them for this proposed reduction:—That the patents stood at cost price, and had only six or seven years to run, and that they were advised that if they earned profits it would not be advisable to pay dividends upon that amount. There was no data furnished for the reduction to £527, which appears to have been a purely arbitrary sum, and is given by the Directors as their opinion of value, without supplying any basis of its calculation.

In proposing this enormous reduction (as a matter of principle and apart altogether from the amount of it) the Directors have merely considered the fact that the patents are running out, and have entirely ignored the goodwill, overlooking that under good management the value of the goodwill of the business should increase in at least the amount of the diminution of the value of the patents.

It is obvious that the mere goodwill of a business which is said to earn £5,000 per annum from its installations must be worth immensely more than £527.

As to the general business of the Company, under the existing system of management it has not been, and it is not possible that it should be, worked with either efficiency or economy.

There is no proper system of check or control of stores issued. The books of the Company are not properly kept, and some of them are even now not posted since January last. The Company have obtained many orders for lighting and have left them unexecuted for several months, in some cases actually going to the expense of running the wires without fixing any lamps. There is no reserve of power at the Stanhope-street installation for any further business, and at Whetstone Park installation there is no reserve of boiler power, and the whole installation is at the risk of a breakdown from the leakage of a single tube.

The sum of £4,769. 7s. 5d. has been realised from the sale of Consols by the Directors, and spent by them during the period in which two of the three Directors were disqualified and their office vacant without any improvement in the financial position of the Company, and but for the

repayment by them since the last meeting of £200, which they had improperly paid themselves for Directors' fees, the Company would have had absolutely no money at the bank at the commencement of this investigation.

In the now existing condition of the Company, it is, of course, necessary that capital should be obtained to enable it to carry on its business properly or at all. The business, if properly managed, should be a successful and profitable one, as the system of lighting is exceedingly popular with all its customers, the number of whom might be almost indefinitely increased.

It is regretted that it has not been possible to submit this report to the shareholders at an earlier date, but the committee have not been facilitated by the Directors or the secretary in their investigation, and from the 29th March to the 4th inst. the offices of the Company were closed, the secretary absent, and the books locked up, although he had been distinctly informed that the committee desired to have access to them, and continue the investigation during that period.

During that absence of the secretary and manager, one of the installations had to discontinue its lighting of a public-house at 9:30 in the evening because at the Stanhope-street factory there were no coals.

The attitude of the Directors in regard to the investigation will appear from the following letters :—

"68, Cornwall Gardens, Queen's Gate, S.W.,
"23rd March, 1888.

"Dear Sir : I have been expecting to hear from the committee appointed at the 'Pilsen' meeting on the 13th inst., to confer with myself and my late colleagues, but hitherto I have received no communication from them. Mr. Trentham informs me that you wish to take stock. At present I do not see the utility of this, or that it comes within the scope of the resolution, but, of course, I shall be glad to hear what the committee has to say on this subject.

"For this or other purposes it seems to be in accordance with the resolution that there should be a meeting of the committee with myself and my late colleagues, and upon hearing from you I will either convene such a meeting myself or will endeavour to arrange to meet the committee with my colleagues.

"I do not read the wishes of the shareholders as expressed by the resolution to be that you or the committee should take any action at the factory or at any of the installations except in conference with me.

"I take the opportunity of informing you that the intervention of the Easter holidays and the convenience of the shareholders seemed to me to make it desirable to hold the meeting to elect Directors on the same day as the adjourned meeting (13th April). Notices will be shortly issued accordingly.

"Please communicate this letter to the committee.—Yours faithfully,
(signed) "RAWSON W. RAWSON,
"Chairman of the Pilsen Joel and General Electric Lighting Company (Limited)."

"St. Stephen's-chambers, Telegraph-street, E.C.,
"27th March, 1888.

"PILSEN AND JOEL COMPANY.

"Dear Sir : I beg to acknowledge the receipt of your letter dated 23rd, but delivered on the 25th inst.

"Neither I nor my colleagues on the committee whom I have been able to consult can accept your view as to the very limited scope of the investigation which you suggest ; but, of course, when we are in a position to do so usefully by means of the investigations we are making, we shall wish for an opportunity of conferring with yourself and the late Directors, and will ask you to be so good as to arrange it.

"I cannot but think it was a strong proceeding to delay the meeting for election of directors, when the secretary had been directed by the shareholders to send out notices *forthwith*.—Yours faithfully,
(Signed) "JAMES FYFE.
"Sir Rawson W. Rawson, K.C.M.G., &c."

Dated this 12th day of April, 1888. ANDREW HUTTON.
JAMES FYFE.

CITY NOTES, &c.

ANGLO-AMERICAN TELEGRAPH COMPANY.—The directors of this company have resolved to declare an interim dividend for the quarter ended 31st March, 1888, of 5s. per cent. on the ordinary stock, and 10s. per cent. on the preferred stock, less income-tax, payable on the 1st May to the stockholders registered on the books of the company on 10th April, 1888.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended April 13th, 1888, amounted to £4,649.

GREAT NORTHERN TELEGRAPH COMPANY OF COPENHAGEN.—The accounts of this company for 1887 show that, including £31,586 brought forward, the revenue was £310,802. The total expenses came to £64,798, and provision being made for interest on and amortisation of debentures, there was a balance which admitted of the payment of a dividend of 2½ per cent. in addition to the interim dividend of 5 per cent. The sum of £55,555 was added to the reserve and renewal fund, and £41,921 was carried forward, after an addition to the pension fund and directors' remuneration had been provided for. The final dividend announced for 1886 was also 2½ per cent.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended April 13th, 1888, after deducting the "fifth" of the gross receipts payable to the London-Platino-Brazilian Telegraph Company (Limited), were £3,787.

REMOVAL.—Mr. Julius Sax informs us that, owing to the necessity for increased accommodation in his office and show rooms, he has removed those departments to Ridgmount-street, Bedford-square, and communications are in future to be addressed as under :—Sax's Electrical Engineering Works, Ridgmount-street, Store-street, W.C. (three minutes' walk from 108, Great Russell-street).

NEW COMPANIES REGISTERED.

SOUTHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED). Registered by Richard Jordan, 120, Chancery-lane, W.C. Capital £30,000, divided into 4,000 Preferred shares of £5 each, and 2,000 Ordinary shares of £5 each. Object : to carry on the business of electricians, mechanical engineers and manufacturers, and workers and dealers in electricity, motive power and light, and generally any business in which the application of electricity, or any like power is, or may be useful, convenient, or ornamental, or any other business of a like nature ; to carry on the business of manufacturers of and dealers in machines, lamps, lanterns, safety lamps and other appliances for supplying light and power by means of electricity. The first subscribers are :—

	Shares.
J. H. Aldridge, M.D., 13, Anglesea-place, Southampton	1
J. Bishop, boot manufacturer, Grosvenor-square, Southampton	1
E. G. Rose, brewer, Westwood, Southampton	1
J. Appleford, merchant, Millbrook, Southampton	1
J. G. C. E. Vanore, Lloyd's agent, Southampton	1
J. Miller, outfitter, 177, High-street, Southampton	1
E. Brown, butcher, 17, Above Bar, Southampton	1
R. Allen, 183, High-street, Southampton	1

There shall not be less than three nor more than twelve directors. The first shall be appointed by the subscribers to the Memorandum of Association. The qualification of a director shall be the holding in his own right of shares of the nominal value of at least £250. The remuneration to the directors shall be fixed by the company in general meeting.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

2,313. S. ZIANI DE FERRANTI. London. Improved means for obtaining a uniform continuous current from dynamo-electrical machines. February 15, 1888. This application having been originally included in No. 2,313, dated February 15, 1888, takes, under Patents Rule 23, that date.

5,127. J. S. GISBORNE. London. Improvements in electric telegraphic apparatus for transmitting and receiving signals on board ship or other places. April 6, 1888.

5,131. C. A. RANDALL. London. A magneto-electro storage motor. April 6, 1888.

5,162. W. M. MORDEY. London. Improvements in electric generators. April 7, 1888.

5,182. R. C. STONE and J. GILFILLAN. London. Improvements in telegraphic transmitters. April 7, 1888.

5,191. H. EDMUNDS. Streatham. Improvements in storage batteries. April 7, 1888.

5,196. M. H. SMITH. London. Improvements for conducting and collecting currents in electric rail or tramway systems. April 7, 1888.

5,201. D. H. DAVIES and J. M. TOURTEL. London. Improvements in apparatus for effecting by introduction of a coin production of electric light for a certain time. April 7, 1887.

5,233. A. H. WALTON. London. Improvements in fusible cut-outs for electrical circuits. April 9, 1888.

5,259. J. V. CAPEK. London. Improvements in electrical heating. April 9, 1888.

5,377. J. M. CROOM. Edinburgh. Lubricators actuated by electro-magnets. April 11, 1888.

5,390. J. SHERRIN and J. VAUGHAN SHERRIN. London. Improvements in velocipedes and other vehicles propelled by electricity. April 11, 1888.

5,393. A. F. ST. GEORGE and C. R. BONNE. London. Improvements in galvanic batteries. April 11, 1888.

5,421. W. ROBSON. Durham. Perpetual motion and electric current generator. April 12, 1888.

5,433. T. PREECE and T. R. ANDREWS. Bradford. Improvements in electric matting. April 12, 1888.

5,436. G. A. NUSBAUM. London. Improvements in automatic call-box for telephonic communications. April 12, 1888.

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5,452. J. G. S. CUNNINGTON. London. An improved fusible device for protecting electric circuits. April 12, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

April 14, 1888.

6,221. A. SHIPPEY and W. J. L. HAMILTON. London. A mode of and apparatus for governing or regulating by electro-chemical action applicable to the regulation of motors and of the feed of arc lamps, and for other regulating purposes. April 28, 1887.

6,581. E. MANVILLE and W. L. MADGEN. London. Improvements in holders for electric lamps. May 4, 1887.

7,265. C. ADER. London. Method and apparatus for phonic reception of electrical signals. May 18, 1887.

9,853. H. WATT (of the firm of H. Watt and Co.). London. Improvements relating to dynamo-electric machines. July 13, 1887.

12,017. P. L. VERCHÈRE. London. Improvements in the manufacture of carbons for voltaic batteries and certain other electrical apparatus. September 5, 1887.

633. C. COERPER. London. Improvements in dynamo-electric machines. Jan. 14, 1888.

734. J. NOAD. London. Improvements in galvanic batteries. January 17, 1888.

3,685. S. SHARP, J. M. V. MONEY-KENT and H. J. PAYNE. London. Improvements in electrical switches. March 9, 1888.

3,740. A. BERNSTEIN. London. An improved combined cut-out and switch. March 10, 1888.

PATENTS SEALED.

April 13, 1888.

3,685. R. DICK and R. KENNEDY. Glasgow. Improvements in alternating-current transformers or induction coils. March 10, 1887.

3,767. J. LEA. London. A method of checking or arresting the feed of an arc lamp and appliances for the purpose. March 12, 1887.

4,070. M. H. P. R. SANKEY and P. W. WILLANS. London. Improvements in combined engines and dynamos. March 17, 1887.

4,781. THE ELECTRICAL POWER STORAGE COMPANY (LIMITED) and H. W. BUTLER. London. Improvements in electric batteries. March 30, 1887.

4,809. E. TORTORA. Florence, Italy. Improvements in insulating electrical conductors. March 31, 1887.

17,837. P. M. JUSTICE. London. Improved means of generating electricity from heat (E. G. Acheson, United States). December 28, 1887.

17,888. G. A. SMITH. Goole. Improvements in and relating to electro-magnetic marine governors. December 29, 1887.

17,965. F. REDMOND. Dublin. Improved machines for cleaning windows, mirrors and similar articles, by either mechanical or electrical power. December 31, 1887.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

4,116, 1887.—A. F. ST. GEORGE and C. R. BONNE. Electric incandescent lamps. (Price 8d.)

5,862, 1887.—W. BLENHEIM. Simultaneously driving clocks by magneto electricity. (Price 8d.)

5,958, 1887.—A. M. CLARK. Maiche. Dynamo electric, &c., machines. (Price 8d.)

6,754, 1887.—R. E. B. CROMPTON and J. SWINBURNE. Dynamo-electro machines. (Price 11d.)

6,917, 1887.—W. M. MORDEY and C. E. WEBBER. Electric transformer induction coils. (Price 8d.)

6,987, 1887.—A. SIEMENS. Electric arc lamps. (Price 8d.)

7,021, 1887.—G. SCARLETT. Electro-dynamic machines. (Price 8d.)

112, 1888.—H. F. JOEL. Incandescence lamp holders, &c. (Price 6d.)

506, 1888.—E. M. DORMAN and R. A. SMITH. Incandescent electric lamps. (Price 6d.)

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ORDINARY WATCHES may easily become Magnetised, but such an accident was of rare occurrence until recently; but now, owing to the large number of Dynamo machines in use everywhere, it frequently happens.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, April 18, 1888.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending April 18, 1888. Highest.	Lowest.
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	38½ 39½	3 10 6	Jan., Apr., July, Oct.	39	38½
2,614,820	Stock	20/0	Do. Preferred	64½ 65½	4 5 4	,, ,,	66	64½
2,614,820	Stock	nil.	Do. Deferred	13 14	...	February	14	13½
130,000	£10	3/0	Brazilian Submarine	12¼ 12½	5 12 0	Mar., June, Oct., Dec.	12⅝	12⅜
16,000	10	8/0	Cuba Submarine	12¾ 13¼	6 0 9	February and August	13¼	13
6,000	10	10/0	Do. Preference	19 20	5 0 0	,, ,,	19	...
12,931	5	2½%	Direct Spanish (£4 paid)	3¾ 4¼	3 10 0	March & September	3⅞	...
6,000	5	5/0	Do. Preference	9 10	5 0 0	April and October ...	9½	9½
60,710	20	2/0	Direct United States	8⅝ 8⅞	4 11 6	Jan., Apr., July, Oct.	8⅞	8¾
380,000	10	2/6	Eastern ...xd	11⅝ 11⅞	4 12 7	,, ,,	11⅞	11⅝
70,000	10	3/0	Do. 6 per Cent. Preference ...xd	14¾ 15¼	3 18 0	,, ,,	15¼	14⅞
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	100¼	109
250,000	10	5/6	Eastern Extension	12¾ 13	4 14 3	Jan., Apr., July, Oct.	13	12¾
22,050	10	5/9	German Union Telegraph and Trust	9 9½	6 3 3	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust ...xd	5⅞ 6⅛	4 12 0	Jan., Apr., July, Oct.	6⅛	5⅞
178,992	10	3/0	Do. 6 per Cent Preference ...xd	13¾ 14	4 5 8	,, ,,	14	13 13/16
150,000	10	5/0	Great Northern	14½ 15	5 0 0	Jan., July, and April	...	...
17,000	25	5%	Indo-European	38 40	6 5 0	April and October ...	...	...
38,348	10	3%	London Platino Brazilian	5¼ 5¾	5 4 4	May and November	5⅝	...
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October ...	...	...
338,225	Stock	15½%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	5¼ 5¾	8 13 9	January and July ...	...	...
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88,321	10	nil.	West India and Panama	¾ 1	...	...	...	...
34,563	10	9/0	Do. 1st Preference	10½ 11	6 19 6	April and October ...	10¾	10 11/16
45,181	15	3/9	Western Brazilian	10 10½	7 11 6	March & September	10 3/16	10
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅝ ¾	5 9 0	Yearly	...	...
220,000	£1	...	Oriental (11s. paid)	5/16 7/16	...	...	⅞	...
80,000	5	5/0	United	14½ 15	4 6 8	June and December	15⅛	14⅝
50,000	5	2/6	United River Plate	5 5¼	...	April and October ...	5⅛	5 1/16
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb.'86	Anglo-American Brush (£4 paid)	2¾ 3¼	...	...	...	...
23,692	5	2/0 ,,	Do. (fully paid)	3⅛ 4	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅜ 2⅝	...	...	2½	2 7/16
312,000	¼	5% '86	Maxim-Weston	1/16 3/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39½ 40½	5 18 6	March and July	40	39
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	17½ 18½	5 8 1	February & August	18	17⅛

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 519.—Vol. XX. FRIDAY, APRIL 27, 1888. Price 4d.

NOTES.

After remaining in a state of suspended animation for nearly four years, the International Convention for the protection of submarine cables entered into by the high contracting parties in 1884, and confirmed by a Bill in the British Parliament the year following, is to come into force next Tuesday, the 1st of May. We said of this Bill at the time that submarine cable proprietors would have been much better without it, chiefly because, although it took measures for the protection of existing cables, it made no provision—so far, at least, as these shores were concerned—to regulate the laying of fresh cables. Much, however, will depend on how the Act is interpreted; and now that the British Government is going to set up a large cabling business of its own, some fairer consideration may be given to the rights of private companies than was apparent when the Convention met.

We would direct attention to the highly valuable series of constants calculated by Mr. W. H. Preece in continuation of his recent investigations upon the relation between the fusing currents and diameters of wires of different metals. The final values arrived at are given in some tables which will be found in another column of this issue.

That famous transpontine theatre, once too well known as the "Vic," was a few years ago converted into a respectable and useful institution for the decent recreation and instruction of the South London working classes. This wholesome transformation came about mainly through the liberality of the late Samuel Morley; and it will be seen by a letter which we print elsewhere that to carry on the work the freehold of the property will now have to be purchased outright. An effort is being made to raise the necessary funds, and as the "Royal Victoria Hall" is doing excellent service—amongst other things, to the cause of technical education and science teaching—we commend the appeal to the generosity of our readers.

We cannot regard the omission of the "goodwill" principle from the purchase clause of Lord Thurlow's Bill with any degree of satisfaction. It may, perhaps, be true, as Lord Thurlow would have us believe, that "it is essential for the passage of the Bill through another place that the word 'goodwill' should not be in it." But we think it a pity to throw this sop to Cerberus before his appetite "in another place" has at least been tried. We are rather at a loss as to the construction to be placed on Lord Thurlow's remark that on behalf of the Electric Lighting Companies he was authorised to accept the omission of the term. We find it difficult to believe that the "authorisation" was in accordance with the views of the entire trade. After hearing Lord Thurlow's statement, Lord Salisbury, who at first intended to oppose the amendment, remarked that he supposed the companies knew their own business best, and therefore refrained from opposition.

If, however, the suggestion of Lord Herschell be adopted at a later stage we are inclined to think that no harm will be done. Lord Herschell very sensibly remarked that if the conditions imposed upon the undertakers were of such a character that at the end of a given term they would not get full value for their property the result would be that "the present generation would pay more for the electric light in order that, some thirty or forty years hence, the next generation should have it for less than they ought to pay." If, however, the term "goodwill" was taken to be of such sinister import that its presence would wreck the Bill, he would prefer to substitute the term "market value." We take it that this suggestion is really a clever piece of *finesse* on the part of Lord Herschell, for he is no doubt aware of the fact that by a recent decision of the House of Lords the latter term has been held to include the former. We trust that this may escape the attention of the party of confiscation.

Mr. Plunket's remarks the other evening relating to electrical communication between the House of Commons and the Library and Smoking Room appear to have been imperfectly understood, leading at least one of our contemporaries to state that such communication had been established. This, however, is not the case, all attempts at introducing the Exchange Company's automatic system, which is the one suggested to meet the wishes of members, having hitherto failed. The "majority" referred to by Mr. Plunket as being against the proposal no doubt resemble most majorities in liking not only to speak but to be listened to, and not merely to be recorded speaking "off the tape." Nevertheless, the singular fact remains that members of Parliament at their clubs are better informed of what is going on in the House than they are when at St. Stephen's itself, anywhere outside the Commons' doorway.

The report of the committee of investigation of the shareholders of the Maxim-Weston Electric Company will be

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found embodied in the report of the adjourned meeting of the Company in another part of our issue. The presentation of this document and the reply of the Chairman thereon led to a prolonged and stormy discussion, and in the end an enlarged committee was appointed to pursue the investigation further. Apart altogether from the internal affairs of this Company, those who have followed its history the most narrowly will, we think, feel the least surprise at the present turn of affairs. The immediate cause of the present explosion is, however, apparently to be found in the anomalous position of the Company in respect of the "Watt" patents. These patents are not at present the property of the Company, but belong apparently to Mr. HUGH WATT, M.P., himself. Nevertheless, according to the statements of Mr. KLENCK, the development of the "invention" has been carried on for twelve months, at the Company's works, and by their own servants—a sum even appears to have been paid for "salaries" in this connection. Mr. WATT'S explanation of this peculiar arrangement, so far as we understand it, amounts to the statement that the Company would have received a *quid pro quo* in the shape of the extremely small royalty which they would have to pay the patentees on the machines manufactured. He is also perfectly willing to repay the sums hitherto expended. Now, this may or may not have been a highly advantageous arrangement on behalf of the Company, but the fact that their chairman appears to some extent to have occupied a dual position in the transaction naturally leads the shareholders to desire a somewhat more definite understanding.

THE automatic adjustment of alternate-current machines when connected in parallel has received a remarkably neat solution by Mr. SWINBURNE. His method is described and illustrated in our report of the discussion on Mr. CROMPTON'S Paper. It will be seen that it practically amounts to a contrivance for lessening the load on any machine immediately it gets out of step with the others. The load is lessened by a purely electrical device, which increases the self-induction, and therefore the lag, in the circuit of the machine. The effect is to cause a momentary tendency to race, and thus to restore synchronism.

MR. ROBERT HAMMOND'S impressive and vigorous address has certainly formed the most distinctive feature of this prolonged discussion. It was perhaps conceived in a vein to which the Society is a little unaccustomed, but if so it had at least all the charm of novelty. It must also be admitted that Mr. HAMMOND had a distinct and legitimate grievance against the author of the Paper for having spoken scornfully of the lighting at Brighton and Eastbourne. As regards the former place, our readers will recollect the elaborate description which appeared in these columns in November last, and do not need to be told that the installation is in every sense of the word a complete success, and by no means open to Mr. CROMPTON'S charge of being "confessedly carried out in a temporary manner."

BY-THE-BYE, it was before Mr HAMMOND had risen that another speaker observed that there had been "a good deal of Pears' soap business done at the Society of late." The remark is certainly justifiable; but if members of the Council are the first to set the example, how are others to be blamed for following it?

WE would direct the attention of students of alternating currents to the highly valuable Paper "On the Variation of the Coefficients of Self-Induction," read by Mr. SUMPNER before the Physical Society. The sorrowful conviction has for some time been gaining ground that the treatment of coefficients of induction as constants, and alternate currents as sinusoidal functions, may often lead to conclusions very far astray. Mr. SUMPNER, though not the first to recognise these facts, is, we believe, the first who has faced the consequences, and carried on the investigation upon these lines. *Inter alia*, it will be found that the Paper suggests a possible explanation of the recent experiments of Dr. LODGE, which show that iron is preferable to copper for lightning conductors, without necessitating the assumpt ion that iron has less self-induction than copper for high rates of alternation.

A RECENT article on the Telegraphs in China, signed J. M., in *Nature*, is interesting, chiefly perhaps for the information it affords relating to the telegraphs in Japan, with which the writer appears to have a personal acquaintance. The Japanese telegraph system, we are told, now extends to every town of importance in the Mikado's dominions. The four islands are connected by submarine cables, and the whole system with the outer world by means of the Great Northern Telegraph Company's lines. Still more gratifying is the statement that all the stores and electrical apparatus are manufactured by Japanese artisans, and that the engineering staff, as well as the operators, are educated and trained on the spot, without external or foreign aid. The lines are carefully inspected and thoroughly well maintained throughout; and the rates, although sufficiently low to bring the convenience within the reach of all classes, are remunerative to the Japanese Government, to whom of course the local telegraphs belong.

BUT, turning to the writer's main purpose, which is to show what might be accomplished in the empire of China, the natives of which are as intelligent and as skilful as those of Japan, and the ground to be covered eighteen times larger, we are met by some contradictions that leave the immediate prospects of telegraphy in the Flowery Land as uncertain as ever. The writer's chief anxiety seems to be to get the lines erected at once "almost in any fashion, so long as they can be made to convey a message, if even, as is most probable, the entire system has to be reconstructed at a no distant date." His first aim is "so to familiarize the natives with the aspect of the intrusive posts and wires that they will combine to protect rather than destroy them." Yet we are assured further on that, whereas in Japan the people were hostile and the Government friendly to the telegraphs, in China the reverse is the case, the people being friendly, and the Government, until recently, hostile. Then follows the warning that "it will be better not to construct the lines (in China) at all," unless they are adequately maintained in "efficient working order," lest public confidence in the innovation should be shaken. How the Chinese are to be

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familiarized with the poles and wires, regardless of their stability, and convinced of their efficiency at one and the same time, is not explained. If the natives of the interior are not going to meddle with them, the wires might as well be erected permanently in the first instance.

THIS week's issue of *The Electrician* consists of 72 pages, and is accompanied by a presentation steel-plate portrait of Sir JOHN PENDER, K.C.M.G.

The Electric Light in China.—The Chinese Governor of Tamsui has had his palace lighted by electricity.

The West Indian Cable.—It is announced that the cable between St. Vincent and Barbadoes is now repaired.

The House-to-House Electric Lighting Company. — We understand that Mr. A. P. Trotter has severed his connection with the above company.

Birmingham.—The banking premises of Messrs. Lloyds, Barnetts and Bosanquets are being supplied with electric light. The installation will consist of fifty lamps.

The Gaulard-Gibbs Transformer Patents.—It is announced that the Gaulard transformer patents in France have been acquired by a powerful syndicate, at the head of which is the Banque d'Escompte.

Electrical Music.—A provincial paper states that "Signor Bozza" has invented a new musical instrument, playable only by electricity; it is made of porcelain, "and from it he produces music quite unique in sweetness and penetration."

Boulogne.—Some 700 incandescent and 30 arc lamps have recently been installed in the Casino at Boulogne-sur-Mer, the arcs being intended to light the gardens. Two 100 horse-power Edison dynamos furnish the necessary current. The installation has been carried out by the Edison Continental Company.

Central Station Lighting at Bremen.—The contract for providing a central electric light station at Bremen has been awarded to Messrs. Spiecker and Co., of Cologne, whose tender amounted to £30,000. We believe that several English firms sent in tenders. A large number of accumulators will be employed in this station.

Cairo Telephone Company.—Owing to the very severe conditions imposed by the Egyptian authorities, the request of the Cairo Telephone Company to be allowed to run a wire to Alexandria has had no result. The *Bosphore Egyptien* understands that the Government will shortly undertake the matter itself. The Van Rysselberghe system, utilising the existing telegraph wires, will be adopted.

Transmission of Power in Italy.—The factory at Oerlikon (Switzerland) has entered into negotiations with a large Milan firm to erect an installation capable of transmitting 250 horse-power a distance of about 600 yards, with a guaranteed yield of 78 per cent. The motive power is to be furnished by turbines driving two Oerlikon dynamos, the current being transmitted to the two motors in the factory by three wires, as at Kriegstettin.

The Effect of Air Pressure on Radiation.—M. Cailletet has conducted a series of experiments which show that the heating effect of a current on a piece of platinum wire is proportionately diminished as the pressure of the air around such wire is increased. The converse has long been established. M. Cailletet has shown that a current which would fuse a wire under ordinary pressure will scarcely raise it to redness when the pressure is sufficiently great.

Simla: Lighting the Viceregal Lodge.—Arrangements have been made for lighting the new Viceregal Lodge at Simla by means of electricity. This work has been entrusted, as regards the electrical apparatus, to Messrs. Siemens Bros., London, and will in all probability be completed before Lord Dufferin takes up his residence at Simla for the hot weather. His Highness the Maharajah of Bhownuggur has also ordered an installation of electric lighting for one of his palaces. Messrs. Siemens Bros. and Co. are supplying the whole of the plant for this installation also.

The Electric Light on Ships.—In the course of his remarks at the general meeting of the Royal Mail Steam Packet Company, on Wednesday, Mr. Eden Colvile (the chairman of the company) said:—"We have put the electric light into twelve of our ships, and from the experience we have had, from what we hear from the passengers generally, that is exceedingly judicious expenditure. It is a very favourite light among the passengers. It is a much safer light, I think, as against fire than burning oil lamps or candles. I cannot say it is a saving in expenditure actually, but we feel the effect in the increased numbers of passengers we carry, to whom it gives great satisfaction."

Liverpool.—An "International Brewers', Vintners', and Industrial Exhibition" is to be opened at New Brighton early in the ensuing month. The contract for the electric lighting has, we understand, been entrusted to Messrs. Hills and Thomson, of Liverpool. Both arc and incandescent lamps will be used, including some of the high candle-power "Sunbeam" incandescents. Messrs. Hills and Thomson have been introducing the "Sunbeams," with great success, for ship lighting, having recently fitted them in, amongst others, the Atlantic liner the "City of Rome," in place of the arc lamps formerly in use in the engine rooms, and for cargo lights. There is doubtless much to be done in this direction.

Kensington Vestry.—The Works Committee of the Kensington Vestry have reported that they have again considered the application by the Kensington Court Electric Light Company (Limited) for permission to open the footpath in parts of Kensington High-street for laying wires, and a proposal for running wires in a portion of the route through the sewers; and recommended that permission be granted on condition that the work is carried out at night in places where interference with trade, &c., would otherwise result; and that it be executed to the satisfaction of the vestry's surveyor.—Mr. Braye moved that it be referred back for the Works Committee to reconsider.—Mr. Oliver seconded, and this was carried.

Search Lights in the Navy.—The mimic naval operations of last year and the more recent tests of the value of the defences of Malta, when attacked at night by vessels equipped with powerful electric search lights, have conclusively demonstrated the utility of the electric light in all naval operations conducted under the cover of night. An order has now been issued that every vessel in the British Navy is to be so fitted, provided that the boilers are in a sufficiently good condition to admit of the requisite pressure being maintained, and no ship is to be constructed in the future without provision being made for at least four search lights. An officer specially appointed will supervise all electric fittings in ships of war dealt with in home dockyards.

The Electric Light in Italy.—During the month of February the Terni Central Station has been opened. It has a capacity

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of 3,000 16 candle-power lamps, the plant comprising three groups of machines, each group consisting of a 150 horse-power Girard turbine, a 2,000-volt 40-ampere alternate-current dynamo, and an exciter. The station is outside the town, 200 metres from the walls. The current is distributed by means of 21 Zipernowsky transformers, each of 7,500 watts capacity, the difference of potential at the secondary terminals being 100 volts. In addition to private consumers the light is supplied to the town, 350 lamps of from 10 to 50 candle-power being charged for at from 4 to 13 centimes an hour. All the wires are bare, and run overhead.—The electric light has also been introduced to a Avellin and Omegna, the station at Avellino being capable of supplying 2,500 incandescents.

Mexico and Cable Extensions.—Reports have been circulating in Mexico to the effect that English capitalists had under consideration a project to lay a cable between London and Havana, with the intention of extending it to Yucatan, the most eastern State of Mexico. A correspondent of a local paper writes that he has ample authority for stating that any such project would be utterly impossible, for some years to come at any rate, seeing that the "sole concession for laying, working, and maintaining an ocean cable at Havana has already been granted to the Cuba Submarine and the International Ocean Telegraph (International Cable Company, Limited ?) Companies of London." The Mexican paper further states that the Government, by its concession with the Central and South American Cable Company of New York, is debarred from permitting any further competing company to land and operate a cable in the State of Yucatan.

St. James's Vestry and the Electric Light.—As reported in our last issue, the St. James's Vestry, after some discussion, adjourned the consideration of their position with regard to the St. James and Pall-mall Electric Lighting Company, who are applying to the Board of Trade for a license for that district. At a meeting of the Vestry on the following Thursday, Mr. John Bonthron presiding, it was agreed, however, to support the application. The draft license follows the lines of the South Metropolitan Electric Lighting Order, but with two additional clauses—one providing that the Vestry shall not withhold consent to overhead wires during the first three years of the license, and requiring the company to remove all such wires on the expiration of the three years, or at any time required by the Vestry; and the other authorising the company to apply for a provisional order at the expiration of two years. The area of supply is the parish of St. James, Westminster, the compulsory area being so much of the parish as lies south of Burlington-gardens, Vigo-street, Glasshouse street, and Tichborne-street, and the optional area the remainder of the parish.

Electricity in Medicine.—The *Medical Press* writes on this subject as follows :—"If electricity continues to make its way as a therapeutic agent as it has done during the last few years, a working knowledge of the science will soon become indispensable for the general practitioner. Even now, while its therapeutic value is still, to some extent, *sub judice*, its aid in the diagnosis of certain nervous affections could not very well be dispensed with. Yet it must be confessed that only a small proportion of medical men know enough about it to be able to use it to advantage for either diagnosis or treatment. Very few could name the different varieties of currents, still less their particular properties, and, as the recent discussions on Apostoli's treatment have shown, the dynamic value of currents of specified strengths is a mystery even to those who use them. A knowledge of medicine, to be trustworthy, involves a certain familiarity with the sciences, and this is a department which is to a large extent ignored by other than University Examining Boards. It is to be hoped that this, among other shortcomings, will be remedied in any future scheme of medical education."

Electric Light Signalling by Reflection from Clouds.—In our issues of November 18th and December 2nd we referred to the successful experiments which have recently been made in signalling over great distances by means of flashing from arc lights upon the clouds. In continuation of this series of experiments further trials have recently been carried out at Simon's Bay. The experiments were conducted under the direction of Admiral Sir W. Hunt-Grubbe, K.C.B., commander-in-chief. The telegraph wire to Cape Town was supposed to be destroyed, and an electric beam of 100,000 candle-power was directed against the clouds in a series of interrupted flashes, after the manner of a heliograph. It was found that the messages could be read easily at Cape Town. Experiments were then made by a vessel of war from a greater distance at sea, with general success up to a distance of fifty miles, when a change in the conditions of the atmosphere occurred, and the signals could no longer be read. It has been established, however, beyond doubt that this method of flashing signals from hitherto undreamt-of distances is possible, but only under favourable atmospheric conditions.

Train Telegraphy.—The practical value of the system of induction telegraphy on moving trains was well illustrated, says the *Scientific American*, on the Lehigh Valley Railroad during the recent great snowstorm. "In the accident near Three Bridges the train telegraph operator at once telegraphed back to Flemington for a wrecking train. Within a short time Superintendent Donnelly arrived, and during the entire day messages were sent to and from the wrecking train, and surgical relief was obtained. All the beleagured passenger trains, every one of which was equipped with the new system, were located by means of train telegraphy, and provisions were sent to the hungry passengers. Belated passengers sent despatches to anxious wives from the various stalled trains, and all the manifold business of railroading was carried on with celerity. More than 200 messages were sent back and forth over the single line of the company during the three days of delay. The poles used to carry the line are only 16ft. high, and they expose little surface to the storm. The messages are transmitted by induction from the metal roof of the car to the line, a distance of 10ft., and even when cars and line were both buried in the drifts no inconvenience was suffered, as the dry snow acted as a good insulator."

Severe Thunderstorm in Scotland.—The *Glasgow Herald* says :—"A thunderstorm of some severity, accompanied by heavy showers of rain, passed over a considerable portion of Scotland on April 19th. Our Perth correspondent states that the storm was the most severe experienced in that district this season. The flashes of lightning were particularly brilliant, and rain poured in torrents all the afternoon. In Forfar several peals of thunder, evidently at some distance, were heard between twelve and one o'clock, and a few drops of rain fell. The weather, however, cleared a little until two o'clock, when the sky got densely overcast. Two or three very strong and vivid flashes of lightning, followed by tremendous peals of thunder, took place. A flash of lightning struck one of the telephone wires near the central office in Castle-street, rendering it useless for the night. Fortunately no one was hurt, though the officials and some people in the streets were very much startled. A very heavy downpour of rain was expected, but the shower that followed the thunderstorm was comparatively light. At Ayr the lightning was very vivid, and the

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flashes came in close succession. Between one and two o'clock the thunderstorm approached Johnstone from the east and passed over the town. There were some half-a-dozen flashes of lightning, accompanied by peals of thunder."

Portable Electric Lighting Plant for the Austrian Army.—In March, 1887, Messrs. Ganz and Co., of Buda-Pesth, constructed some portable electric lighting plant for the Hungarian State Railways, the plant being required for the purpose of facilitating the "entraining" and "detraining" of troops during the night. This plant was used on two occasions with very satisfactory results during the last autumn manœuvres on the Roumanian frontier. The plant comprises an ordinary eight horse-power portable engine, upon which is fixed a Zipernowsky alternating-current dynamo capable of running eight Zipernowsky 600 candle-power arc lamps. A car somewhat like a furniture van contains the lamps, the masts, a cart with two drums upon which are rolled 2,000 metres of wire, ·003m. diameter, and all the apparatus for erecting the circuit, in addition to two water tanks for the engine. Both engine and van can be easily placed on trucks and taken by rail to their destination. The operation of unloading is easily performed at railway stations, and when it is necessary to unload in the middle of the line two U-pieces are used. The installation can be completed under the direction of an engineer in seven hours, and taken down in five hours. The cost of the eight arcs for ten hours amounts to 17fr. 50c. The whole plant costs about 21,000fr. (£840). Messrs. Ganz and Co. are negotiating with other railway companies with a view to supplying similar plant.

Rouen.—The Thomson-Houston Company have put up nine 1,200 candle-power arc lamps in M. Désiré Giron's factory at Rouen, the power being furnished by a waterfall nearly a mile distant. For a few hours every evening a special circuit is run in two large hot-houses, enabling the members of the Rouen Horticultural Society to experiment with the influence of the electric light upon plants. The offices of the *Patriote de Normandie* will soon be lighted by electricity, the plant comprising a Powell gas engine, a small Thomson-Houston dynamo, and a set of accumulators. The Church of St. Ouen, on the Place de l'Hôtel de Ville, is also being fitted with one hundred 2,000 candle power arc lamps, and a 350 incandescent light chandelier. The Rouen Municipal Council has received several tenders for the lighting of the theatre and town library. No decision has yet been arrived at. The proposed installation is to consist of two 1,000-light Thomson-Houston dynamos, one 500-light dynamo, one 25-arc light dynamo, and a large battery of accumulators; the whole to be driven by Armington and Sims engines. MM. Condors Brothers are about to erect a Thomson-Houston central station at Rouen, and already 2,700 applications for 9,500 incandescents and 1,200 2,000 candle-power arcs have been received. The negotiations with the authorities in this matter are based upon a tax of 25 per cent. on the gross receipts and the installation of the light in all the streets traversed by the subscribers' wires. The wires are to be run overhead on iron posts.

Glasgow Exhibition.—There will be a very fine display of electric light at the Glasgow International Exhibition, comprising 559 arc lamps and 750 incandescent lamps, exclusive of the powerful arc lamps used in connection with the fountains. The Anglo-American Brush Corporation supplies 519 arc lamps, Messrs. Thomson and Houston supply 40 arc lamps, Messrs. King, Brown and Co., of Edinburgh, are responsible for the incandescent installation, and Messrs. W. and J. Galloway and Sons provide the fairy fountain plant. The engine and dynamo room is of ample dimensions, with an overhead gallery for those who desire to see the machinery in motion. The Brush plant comprises nine 35-light and ten 25-light dynamos, the power being derived from no less than seven engines made by four different firms; this plant lights the main portion of the building and all the grounds. The Thomson-Houston installation consists of four dynamos, driven by two vertical engines, the lamps supplied by this firm being placed in the picture gallery. Messrs. King, Brown and Co. have four dynamos, run off two Westinghouse engines, their plant being used to light the refreshment and dining rooms and some of the smaller courts. All the electrical arrangements of the Exhibition have been under the superintendence of Mr. W. A. Bryson. We may add that the main shafting in the dynamo room is divided into sections, the large engines actuatin; the separate sections by means of rope gearing, the pulleys being the "differential tight-grip" pulleys of Messrs. Weyman and Johnson, of Guildford.

The Crystal Palace School.—On Saturday Mr. John Aird, M.P., Assoc. Inst. C.E., presented to the successful students of the Crystal Palace Company's School of Practical Engineering the certificates which have been gained during the term just ended. The school includes a course in electrical engineering, for which a well-equipped laboratory is provided. Mr. Aird reviewed in very favourable terms the work carried on in the several offices and shops of the school, and made some interesting remarks upon his own early associations with the Crystal Palace. He reminded the students that the Crystal Palace itself was a great engineering work, and told them much about the water towers and the hydraulics of the fountains, with which he had been personally concerned. He related how, when the north tower was nearing completion, Mr. Thackeray expressed a wish to ascend it, which he did, by means of ladders, to about half its altitude, when, his nerve failing him, he had to be carefully lowered to the ground. Mr. Aird adverted to the excellent results that were obtained from the work of the school; expressed, as a large contractor, his satisfaction with the specifications the students had prepared, and adjured them to work earnestly and steadfastly. Votes of thanks were passed, on the motion of Dr. Read, to the examiners, Mr. R. Hodson, M.I.C.E., M.I.M.E., and Mr. A. E Preston, A.M.I.C.E., F.G.S., &c.; and to Mr. Aird, on the motion of Major Dickson, M.P., chairman of the Crystal Palace Company. The report was read by Mr. Shenton, superintendent of the Educational Department; and Mr. Wilson, Principal of the School, made some remarks to the students.

Equipment of the Paris International Electric Laboratory The Paris International Electric Laboratory is a one-story building, and the various departments are equipped as follows:—The machine room contains a 20 horse-power Otto gas engine, and connected with it by a counter-shaft is a 20 horse-power steam engine, placed in the yard. The electric machines are a 70-volt, 300 ampere, constant-current Gramme dynamo, an alternating-current Gramme dynamo, and 100-light Edison dynamo, connected with which are two switch-boards, one for the constant currents and the other for the alternating. The photometric room contains a large Bunsen photometer, with a 13ft. scale and the accompanying standard lamps, and a Dumas and Reynault balance for weighing the consumption of oil. The electro-chemical laboratory is equipped with a large number of instruments for obtaining measurements of the electric current by the deposition of silver and other metals, a subject in which the superintendent, M. de Nerville, acquired extensive experience in connection with the determination of the legal ohm. The calibrating room contains standard mecurial resistances, three Deprez-d'Arsonval

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galvanometers, and one Mascart electrometer. The testing of commercial ammeters and voltmeters belongs to this department. The cable testing room contains a full supply of apparatus, comprising Wheatstone bridges, Thomson mirror galvanometers, Deprez galvanometers, a Carpentier dead-beat electrometer, and a Leclanché 100-cell battery. In the main hall are two Thomson graded galvanometers, a small hand Gramme dynamo, a Wimshurst induction machine, a Gaulard and Gibbs transformer, and a 1 horse-power Gramme motor, driving a Romilly pump. This hall is to be used for conferences and special experiments.

Magnesium.—Magnesium is a metal which is perhaps destined in future to play a more important part than has hitherto been supposed. The *Journal* of the Society of Chemical Industry says that the rolling of magnesium does not offer the slightest difficulty, even such complicated forms as T I U, or as angles, round or four-cornered rods, plates or sheets of 0·1mm. thickness. And as pure magnesium is sufficiently resistant to atmospheric influences and can be polished and easily cleaned, it lends itself on account of its lightness and relative strength to the construction of apparatus, &c., required to be made of metal and also to be light, as, for instance, nautical, physical, and astronomical instruments. The working of magnesium requires heat. At a temperature of 450° C., it can be rolled, pressed, worked, and brought into complicated forms. Screws and threads can be made of magnesium, and these are considerably sharper and more exact than those from aluminium. Owing to its cheapness, magnesium can also be used in the manufacture of a variety of useful articles. Experiments in this direction are now being made. The following experiments were made for the aluminium and magnesium manufactory in Bremen, at the mechanical experimental station in Charlottenburg. Tensile strength, limit of breaking, 23·2 kilos. per 1 qmm., specific resistance to compression 27·2 kilos. per 1 qmm., bending strength 17·4 kilos. In comparison with other metals the strength of magnesium is relatively very considerable. The breaking coefficient for tensile strain per square millemetre is :—

		Specific gravity.
Magnesium.....................	23·2 kilos	1·75
Aluminium.....................	20·5 „	2·67
Brass	12·5 „	7·8-9·5
Bronze	23·0 „	8·9
Rod iron......................	38·0 „	7·6-7·8
Delta metal, poured in sand..	34·36 „	8·6
Delta metal, rolled hard ...	53·0 „	—

Exeter.—The Mayor of Exeter (Mr. C. T. K. Roberts) presided over a private meeting of the Town Council at the Guildhall, last week, convened for the purpose of considering the advisability of lighting the city by electricity. The proceedings having been formally opened by the Mayor, an interesting and at times lively discussion ensued, a large number of members being in favour of recommending the adoption of the electric light as an illuminant of the main streets of the city, whilst others opposed it chiefly on the ground that it would be unfair, in the face of existing burdens, to load the ratepayers with the cost of an experiment which might after all turn out a failure. Mr. Massingham, the agent of the Thomson-Houston system, with which the main streets of the city have been lit for some months, was called in, and, in answer to questions put to him by the members, stated that he was prepared to light a quarter of the city from St. Anne's Chapel to Exe Bridge, taking in Queen-street, Bedford-circus, Fore-street, South-street, North-street, and Magdalen-street, with forty arc lamps, which together would give a light equal to 48,000 candle-power, for £800 a year, £20 a year for each lamp. The light would be kept on about ten hours a day, from dusk to daylight. He pointed out that the area he had mentioned was at present lit by 207 gas lamps, which gave a light of about 3,700 candle-power, and cost £809. 7s. 4d. per year.—Several Councillors, while admitting that the electric lamps would have about fourteen times more illuminating power than the gas lamps, were of opinion that they would prove to be inadequate, as they would have to be placed so far apart from each other.—A resolution was proposed and seconded to the effect that in consideration of the present financial state of the city the committee recommended that the proposal to light the city by electricity be not adopted. To this an amendment was proposed to the effect that the various electric lighting companies be invited to inform the committee the price at which they would be prepared to make an installation for the purpose of lighting the city. On being put the amendment was carried by a majority of about half a dozen. A rider was then proposed to the effect that in the event of the price of electricity not being greater than was at present paid for gas the committee recommend to the council the adoption of the first-named illuminant. This was carried *nem. con.*, and the proceedings terminated.

The South Metropolitan Electric Light Company.—A special meeting of the Commission of Sewers was held at the Guildhall last week, to consider a letter from the Remembrancer relative to the application of the South Metropolitan Electric Light Company to the Board of Trade for a provisional order. Mr. W. H. Pannell, who presided, said the Remembrancer would read a letter from the Parliamentary agents to the South Metropolitan Electric Light Company, enclosing a copy of a letter from the Board of Trade stating that it was proposed to consider objections to the license at eleven o'clock on Friday, when the representatives of the Commission of Sewers were requested to attend. The chairman said on the last occasion a resolution was passed by the Commission instructing the Remembrancer to lodge objections to several Bills in Parliament, this being one. The Remembrancer did lodge objections accordingly. The area laid down by the company included part of the area called the Blackfriars site, with regard to which the Commissioners were at the time in negotiation with the Brush Company. This was one of the choicest sites in the whole metropolis for electric light, comprising all the newspaper offices. Since then the Commission had declined to go further with the Brush contract; therefore, an important factor in their application was removed. They had already four applications before the Commission or its committees from four electric lighting companies, with offers to light the whole or a portion of the City.—The Remembrancer (Mr. Goldney) said the previous evening one of the firm of Messrs. Bircham and Co., Parliamentary agents acting for the South Metropolitan Electric Light Company, called upon him to intimate generally that he thought the company might be disposed to discuss terms or meet the objections of the Commission. He (the Remembrancer) intimated to him that the Commission had powers under their own Acts to undertake the whole of the electric lighting themselves. He had since received a letter from the Parliamentary agents asking if it would be satisfactory to the Commission if a clause were inserted to the effect that the powers of the company in the Blackfriars district might be hereafter annulled at the request of the Commission.—The chairman was about to read the objections of the Commission, when the engineer (Colonel Haywood) suggested that they ought to be taken with closed doors.—This was agreed to, and the rest of the sitting was *in camera.*

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SIR JOHN PENDER, K.C.M.G.

The honour of knighthood which has been recently conferred upon the subject of this memoir, and the banquet which was given to celebrate the occasion at the Hôtel Métropole last Monday evening afford a suitable opportunity for continuing the series of *Electrician* portraits which from time to time have been presented to readers of this journal. A small woodcut of Sir JOHN, then Mr. PENDER, has among others appeared in these pages some years ago; but the larger steel plates have been hitherto devoted to the portraiture of men associated exclusively with the scientific development of electric telegraphy. To the hardly less important services rendered by its commercial development the distinguished gathering last Monday evening bore ample testimony, and we have great pleasure in this week being able to publish an excellent portrait of Sir JOHN PENDER, to whom, more probably than to any other individual, that development has been due. Sir JOHN, as everybody knows, is the Chairman of the Eastern, Eastern Extension, Direct United States, and Globe Telegraph Companies, and is the ruling influence in the councils of several other submarine cable companies. But it is, perhaps, not so widely known that in the early days of oceanic telegraphy, when the great experiment in the Atlantic had been tried and had failed, and when the promises held out by electrical science had been almost abandoned in despair, it was Sir JOHN PENDER who pushed the enterprise to a successful issue with the help of his money, his commercial credit, and the whole weight of his personal energy. At a critical moment in the history of the first Atlantic cables the project might have been delayed indefinitely but for the confidence inspired by Mr. PENDER'S heroic offers of assistance. A quarter of a million of money was needed to complete a new cable and make a fresh trial; and for this amount he gave his personal guarantee. The fact seems to have been that Sir JOHN, as has ever since been his custom, took pains to satisfy himself as to the scientific and mechanical problems of the undertaking; and having consulted the highest authorities on these points attacked the financial difficulties himself with perfect confidence in the result. Sir JOHN is a warm patron of science, and to his enlightenment and liberality in this particular are largely due the improvements which continually are made in both the manufacture and the working of submarine cables.

A few particulars of Sir JOHN PENDER'S life and career may be of interest here. He is a native of Scotland, his birthplace being the Vale of Leven, Dumbartonshire. As he was born in 1816 he is now in his seventy-second year, although, as will be seen by the portrait, which is from a photograph taken only in the present year, he looks at least eight or ten years younger, and has still the vigour and faculties of a man not nearly his age. Coming to England soon after leaving the High School at Glasgow, where he finished his education, he entered the counting house of a factory in Manchester, and after a few years' time rose to the management of the establishment. His success in business on his own account later on proved remarkable, resulting in the acquisition of a considerable fortune in the export trade of that manufacturing city, previous to his coming to the Metropolis. His first connection with the telegraph appears to have been in the capacity of chairman to the British and Irish Magnetic Company; and from that period until now his chief energies have been devoted to the promotion of telegraphic enterprise. Sir JOHN represented Totnes in Parliament from 1862 to 1866, and subsequently sat for the Wick Burghs through three successive Parliaments. He is Deputy-Lieutenant of Lancashire and Middlesex, for which counties he is also a J.P., as well as for Denbighshire, Argyllshire and the City of Manchester. Sir JOHN PENDER has been twice married. To his second wife Emma, the daughter of Henry Denison, Esq., of Daybrook, Notts., the fine life-size portrait of Sir JOHN, by Prof. Herkomer, A.R.A., exhibited at the banquet on Monday evening, has been presented by her husband's numerous friends.

THE RISE AND PROGRESS OF TELEPHONY IN THE UNITED KINGDOM.

(Continued from page 537.)

In our last chapter the outline of the general progress of telephony in the United Kingdom, and of the various obstacles, legislative and otherwise, which had to be overcome, has been brought down to the present time. The important judgment which has just been delivered by the Supreme Court of the United States will, we trust, help by its weighty authority to smooth the future path of telephonic progress in this country, as well as in the United States. As the judgment is now appearing in full in the columns of *The Electrician*, it will not be necessary for us to consider it in detail; and we shall now proceed to the consideration of the formation and extension of the different companies by which the telephone system of the United Kingdom is at present being worked.

The parent of all these companies is the United Telephone Company, which, as we stated in a former chapter, was incorporated in June, 1880, by the fusion of the Bell and the Edison Companies, both of which had been formed some two years previously. In the first year of its existence its revenue amounted to little over £20,000, and its profits were under £400, but under the direction of its indefatigable chairman, Mr. James Brand, aided by the indomitable perseverance and keen business qualities of Mr. J. B. Morgan, as managing director, it already showed signs of the vigorous vitality which has enabled it to increase its gross revenue, within a period of little more than seven years, to over £100,000 and its profits to over £62,000.

During its first year it inaugurated the policy of ceding large districts to subsidiary companies, receiving in return sums in ordinary shares, and this policy it has continued to consistently follow, greatly to the advantage of the development of telephonic communication throughout the country. The rapidity of this development will be shown by the table on next page, which gives the dates of incorporation of the different companies, and statistics for the year ending in June, 1887. The letters O. and P. in the columns headed "Dividends" refer to Ordinary shares and Six per Cent. Preference shares respectively.

The United Telephone Company confines its own operations to the county of Middlesex and those portions of the adjacent counties included within a radius of twelve miles from the General Post Office, with a trunk line to Brighton. Its system of exchanges at present in connection with the Central Exchange at Oxford-court, Cannon-street, is shown in the diagram on next page, which indicates the number of exchanges by means of shaded circles, and their connections, without exhibiting their relative positions, which can easily be ascertained by reference to a map of the metropolis and suburbs. The dotted lines in the diagram show the connections with the central exchange, the continuous lines the connections between the local exchanges. The small figures show the number of wires connecting each pair of exchanges.

The United Telephone Company is at present making arrangements to considerably extend its system by establishing exchanges in those suburbs not yet included in the exchange system.

We may therefore anticipate a considerably increased rate of growth in the extension of telephony within the metropolis. Its rate of increase during the last seven years is shown by the figures given below, which give the number of exchanges and private wires in use in the metropolitan system on the 30th of April in each year:—

Year.	Number of Subscribers to the Exchange.	Number of Renters of Private Wires.
1881	914	186
1882	1,673	366
1883	2,745	576
1884	3,350	715
1885	3,820	835
1886	4,393	936
1887	4,619	994

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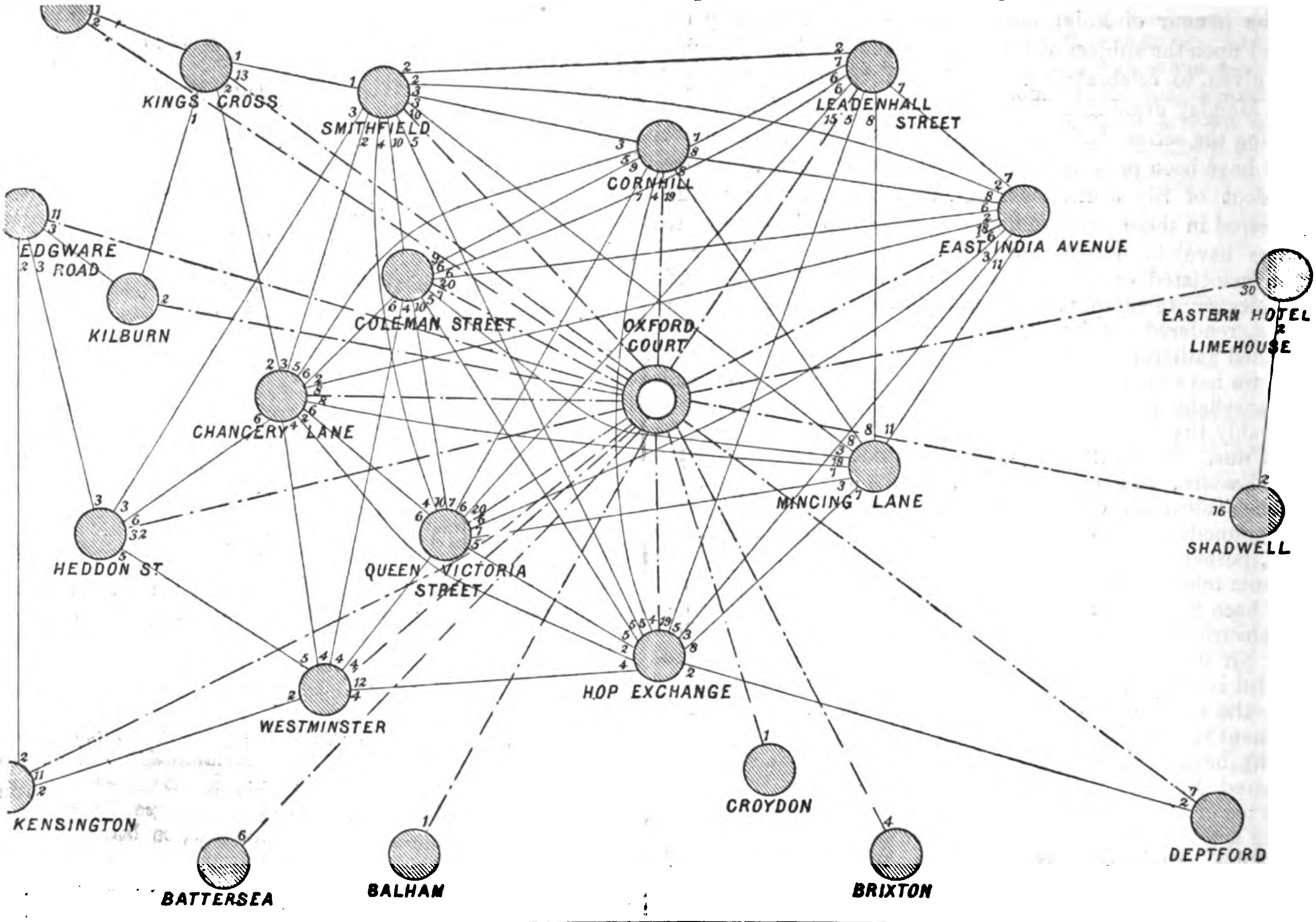
PLAN SHOWING NUMBERS OF WIRES CONNECTING TELEPHONE EXCHANGES IN LONDON WITH EACH OTHER AND WITH THE CENTRAL EXCHANGE. The Local Exchanges are not shown in their true positions.



The following table shows the financial growth of the company during the same period :—

Year.	Metropolitan District, Gross Revenue.	Rentals accrued and Sundry Receipts.	Expenses.	Net Revenue.	Dividend Amount.	Dividend rate per annum.	Reserve Account.	Carried forward.
	£	£	£	£	£		£	£
1881	23,017	20,645	20,274	371	*Nil.*	*Nil.*	4,045	371
1882	37,520	42,625	21,050	21,945	19,583	5%	6,345	2,362
1883	60,105	64,826	38,374	28,814	24,000	6%	12.364	4,814
1884	72,944	92,345	47,688	49,471	34,409	8%	60,275	5,061
1885	84,385	103,000	46,408	61,653	43,804	10%	76,863	5,291
1886	95,655	122,284	54,681	70,277	57,992	13%	97,233	2,285
1887	100,899	130,704	66,955	62,236	58,182	13%	102,646	4,054

Bonus of 10s. per share was declared for the year ended 30th April, 1881.

The total number of telephone "calls" in London during the twelve months ended on the 30th April, 1881, were rather over a million; while during the year ended on the 30th April 1887, they exceeded six and a-half millions. The "calls" for *one day* at the end of April were as follows :—

Year	1882	1883	1884	1885	1886	1887
No. of calls	12,224	19,609	25,957	31,776	32,727	41,947

The total number of "calls" per week for the different companies, for the year 1887, reached the following averages :—

United Telephone Company	221,764
National Telephone Company	420,000
Lancashire and Cheshire Telephone Company	211,500
Western Counties and South Wales Telephone Company	28,000
Telephone Company of Ireland	23,750
South of England Telephone Company	21,881
Northern District Telephone Company	12,690
Total	939,585

STATISTICS OF TELEPHONE COMPANIES, JUNE, 1887.

Name of Company.	Date of Incorporation.	Paid-up Capital.	Gross Receipts.	Net Receipts.	Dividends.	No. of Exchanges.	No. of Exchange Subscribers.	Calls or Messages per day.	No. of Private Wires.	Mileage of Wires run.	No. of Instruments in use.
		£	£	£							
United Telephone	June 3, 1880.	447,555	100,542	62,235	O. 13 %	25	4,622	74,462	1,003	7,500	13,477
National Telephone	March 10, 1881	660,000 75,000	92,000	34,178	O. 4 % P. 6 %	91	6,729	70,000	1,125	9,000	17,547
Lancashire and Cheshire	May 21, 1881.	380,000	87,050	28,050	O. 7 %	48	3,788	55,000	1,347	6,360	12,700
Northern District	Dec. 13, 1881.	194,970 2,000	6,100	3,776	O. nil. P. 6 %	12	441	4,250	122	941	1,631
Telephone of Ireland	May 27, 1882.	212,346	9,997	3,629	O. ¾ % P. 5 %	6	856	3,790	94	668	1,926
Western Counties	Dec. 17, 1884.	354,452	17,750	3,184	O. ½ % P. 6 %	14	1,273	9,810	400	1,489	3,083
South of England	Jan. 29, 1885.	332,866	11,500	1,786	O. nil. P. 6 %	23	1,203	6,000	370	1,000	1,667
Totals		2,659,189	321,939	136,828		219	18,912	223,342	4,461	26,958	52,031

In column 6, O stands for Ordinary Shares, P for Preference Shares.

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The number of messages would be double this, or 1,879,170 per week, which gives ninety-seven and three-quarter millions for the year, and as the gross receipts for the same period amounted to about £320,000, the average cost per message to subscribers would be only a little more than three farthings.

There is but little doubt that this development of telephony has to some extent diminished the number of messages sent by telegraph, as might be expected. In illustration of this we give below a table given in the Postmaster-General's report for 1887 of the development of the Post Office Telegraphs since 1870, from which it will be seen that since the telephone has come into general use in 1880 the number of telegraphic messages did not increase so rapidly as it did previously until the date of the introductn of sixpenny telegrams in October, 1885 .—

Year.	Miles of Wire	Public Messages.	Receipts.	Expenditure.
			£	£
1870–71 ...	68,998	9,850,177	612,301	350,376
1871–72 ...	87,719	12,473,796	735,390	496,694
1872–73 ...	105,285	15,535,780	973,332	833,908
1873–74 ...	108,553	17,821,530	1,049,162	956,170
1874–75 ...	109,778	19,253,120	1,167,745	1,081,937
1875–76 ...	113,216	20,973,535	1,287,623	1,106,912
1876–77 ...	113,333	21,726,143	1,328,315	1,208,401
1877–78 ...	114,009	22,171,867	1,352,668	1,227,560
1878–79 ...	114,242	24,459,775	1,369,467	1,161,551
1879–80 ...	114,902	26,547,137	1,469,795	1,173,287
1880–81 ...	121,052	29,411,982	1,633,886	1,308,453
1881–82 ...	126,734	31,345,861	1,654,390	1,440,498
1882–83 ...	132,456	32,092,026	1,768,070	1,583,876
1883–84 ...	140,499	32,843,120	1,789,223	1,808,920
1884–85 ...	155,568	33,278,459	1,784,414	1,820,764
1885–86 ...	170,196	39,235,813	1,787,264	1,832,401

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

Chapter IX.—*Magnetic Fields.*

102. *Preliminary.*—One of the first considerations towards the understanding of the action of galvanometers is a clear conception of the delineation of the magnetic field set up in and around a coil of wire through which a current is flowing. The needle of a galvanometer is retained in the magnetic meridian, when there is no current through the coil, by the horizontal component of the magnetic field of the earth, and when it is deflected away from its position of rest we must take into account both the magnetic field due to the current which causes that deflection and the field of the earth tending to keep it in the meridian.

The relation between the magnetic field produced at the centre of a coil, the number of turns of wire composing the coil, the strength of current, and the angle of deflection of a magnetic needle free to move in the centre of the coil, is intimately connected with the principle of galvanometers, and it will be shown that the strength of a current may be measured in absolute units by means of a tangent galvanometer when the number of turns of wire, the mean radius of the coil, the horizontal magnetic field of the earth, and the deflection produced by the current are known.

To understand fully these points there should first be a clear conception of the fundamental units employed in the measurement of the intensity of a magnetic field, current, and strength of magnetic pole. To explain these and the manner in which they are co-related we shall have occasion to refer to the centimetre-gramme-second system, from which the units are derived. But we shall first examine the simple physical phenomena of magnetic fields as exhibited by—

1. Permanent magnets.
2. Electro-magnets.
3. Coils or solenoids.

103. *Magnetic Field of Permanent Magnet.*—There is nothing visible nor are there conditions in any way capable of affecting our senses in the immediate neighbourhood of a magnetised steel bar, yet we are well aware that pieces of iron or steel, whether previously magnetised or not, are powerfully acted upon by some invisible force when they are brought into the space surrounding a bar magnet. The whole of this space, which is capable of exercising magnetic force, is termed a "magnetic field" of force.

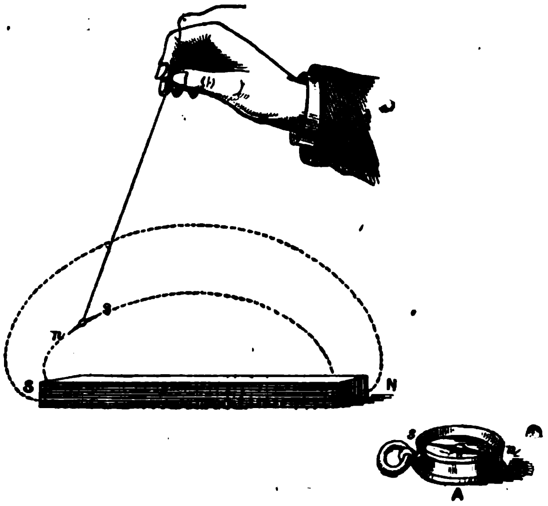

Fig. 60.

If a small compass needle, *n s* (Fig. 60), be attached at its centre to a thread of silk, so that it is balanced in a horizontal position when freely suspended by the silk, it may be employed to explore the character of the field of force round a bar magnet, N S, as shown. A good deal may be learnt by doing this simple experiment. The *direction* of the force will be the direction in which the needle sets itself. Of course, there is the movement here of "translation" or bodily movement of the needle, as well as its turning about its own centre, but by moving the hand about, so altering the distance of the needle from the bar and its position with regard to the ends of the bar, it will be found that when the needle is at rest in any position it will always seem to lie in the direction of curves existing between the two ends of the bar, as shown by the dotted lines (Fig. 60). It will also appear that the compass needle is much more powerfully attracted in some parts of the "field" than in others. This can be told by the rapidity of the oscillations it makes before coming to rest.

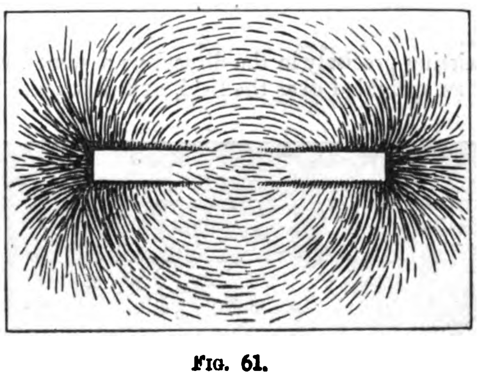

Fig. 61.

Close to the ends of the bar or at the "poles" the strongest force will be observed. In this country we term the north pole of a magnetic needle that pole which turns towards the geographical north, and a mark or cut is made on the north end of most magnets to distinguish this pole. The poles of the bar magnet and compass needle being known, it will be noticed that the latter invariably set themselves in such a direction that poles next to each other are opposite in name. By covering the bar with a sheet of stiff cardboard, or a plate of glass, and letting finely divided iron filings fall over it, at the same time gently tapping the plate, the general character of the

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"field" is observed. Fig. 61 is a drawing from an actual field so taken, and exhibits the direction of the curves of force in the surrounding space. This, of course, only shows the field in one plane, but we should have the same character of field whichever side of the bar was uppermost; and hence the whole of the space immediately surrounding the bar is occupied by these curves of force.

Similarly Figs. 62 and 63 are drawings of magnetic fields taken on a powerful compound horse-shoe steel magnet.

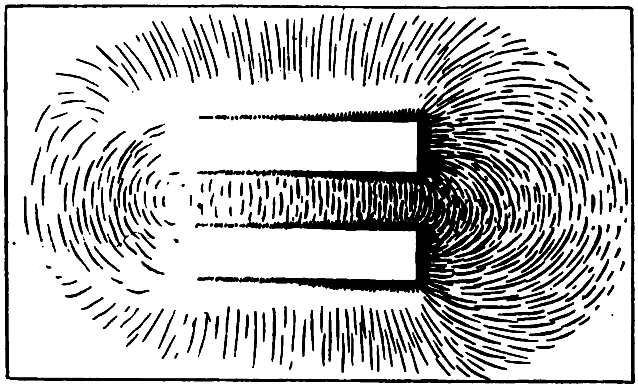

Fig. 62.

104. *Lines of Force.*—Faraday conceived that the space in the immediate vicinity of magnets was occupied by "lines of

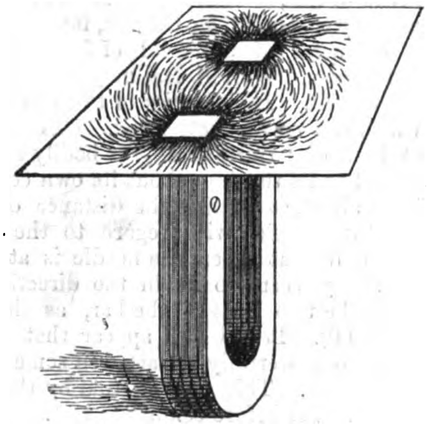

Fig. 63.

force, existing precisely in the directions assumed by the iron filings when sprinkled over the field, and this idea lends itself

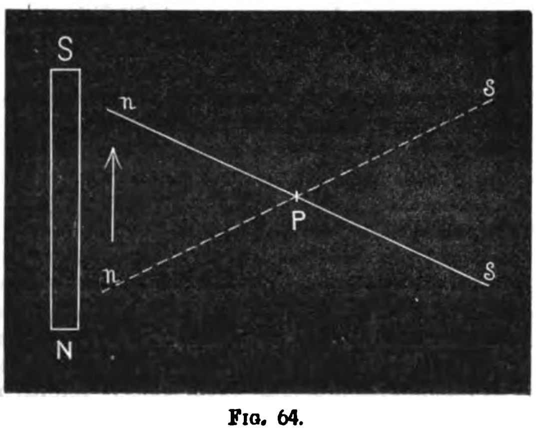

Fig. 64.

very conveniently to the explanation of the various observed effects. It is also convenient to assume a direction for the lines of force; for suppose that the bar magnet in Fig. 60 was turned round, putting the north pole to the left and the south to the right, the effect on the two needles would be to turn them to the right-about-face on their axes, showing that although the lines of force are still there, something has happened analogous to changing their direction. As a basis of reasoning it is assumed that the direction of the lines of force is that in which a free north pole would be moved along the field. As a north pole cannot exist in a "free" state without its corresponding south pole, the nearest practical way of showing this is by taking a long magnetised steel wire, *n s* (Fig. 64), pivoted at P, and holding it near to the bar magnet N S in the dotted line. The action of the distant south pole of the steel wire we may neglect, as it is comparatively so far away, and we have the north pole *n* separately subjected to the action of the bar magnet; and if the long magnet is allowed free movement its north pole will move in the direction of the arrow from N to S, being repelled by one pole and attracted by the other. The assumed direction of the lines of force is therefore from the north pole of a magnet towards its south pole through the surrounding space, but from the south to the north through the interior of the magnet, because all lines are supposed to form a closed circuit, which is completed through the mass of the iron of the magnet. It is also assumed that the greater the intensity of a magnetic field the greater the number of lines of force pass through a given area. We have now to show on what basis the unit magnetic-field is fixed, and as this depends on the force exerted on a magnetic pole placed in that field, the fundamental unit of force on the centimetre-gramme-second system must first be referred to.

JUVENILE LECTURES.

THE APPLICATION OF ELECTRICITY TO LIGHTING AND WORKING.*

BY W. H. PREECE, F.R.S.

Lecture I.

I appear before you to give a short course of two lectures on the application of electricity to lighting and working. To-night I shall confine my attention entirely to lighting, and if we succeed in getting through our subject, we shall devote ourselves next Wednesday to the application of electricity for working tramways, to the transmission of power for various purposes, and generally to working.

Many people imagine the electric light to be a cold light. That is a delusion. It is called a cold light because in many of its forms it gives what we may call a cheerless light; it has not got the warmth, the comfortable look, of other artificial means of illumination.

The electric light owes its existence to the intense heat that the electric current produces, and heat lies at the root of every system of artificial illumination. For instance, suppose we take a common match and light it, we light it simply because by the friction of the two surfaces together we generate heat; the heat burns the substance of which the match is made. We are able to light a common candle because we have applied heat to the wick, the heat liquefies the wax of which the candle is made, the wax is decomposed, it combines with the oxygen of the air, intense heat is produced at that point, carbon is consumed, and the consequence is light. So with all our various modes of artificial illumination. Gas, as you are well aware, produces intense heat, and the result of that heat is light. There are various ways in which gas is applied to produce heat and the necessary consequence—light. Here is a Sellon gas-burner, in which the combustion of gas raises the temperature of a fine platinum cap, and the result is, as you see, a very beautiful light. In one lamp we have a cap or mantle, in the other case there is merely a flat disc gauze of platinum. The combustion of the gas produces intense heat, which raises the network to a very high temperature, though in the present

* A course of three Lectures delivered before the Society of Arts on January 4th, 11th, and 18th.

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case the light is not so good as it should be, probably through the pressure in the supply main not being sufficiently great.

In another case we have a gas jet surrounded with a network of some vegetable matter, linen or cambric, steeped in a solution of salts of zirconium, and a few other rare earths, and the intense heat of the gas causes a very high temperature, and, as you see, a very brilliant effect is produced.

You will see from this that in all cases of artificial illumination bodies have to be raised to a high state of temperature. I hold in my hand a piece of magnesium wire; it is really flat magnesium tape, but it is called wire. If I heat that you will observe that a very brilliant light is produced, due to the very high temperature at which it burns. Now, if I take a lump of coal and heat it—it requires to be raised to a certain temperature before the oxygen is directed upon it—and subject it to a jet of oxygen, you will see that it burns with very much more intense light than you are accustomed to in the ordinary fire. If I take a piece of iron wire and place it in a jar of oxygen, you see what a very brilliant effect the combination of oxygen and iron produces through the iron being raised to a very high temperature.

I have now shown you that in order to produce light we must, by some means or other, raise the temperature of a body. But the high temperature that we have to deal with is not that produced by the combination of the oxygen of the air and carbon, and other bodies such as I have shown you, but it is produced by the aid of the electric current. In all these cases the result of the combustion you have seen has been to remove oxygen from the air, but now I want to show you how a body can be raised to a high state of temperature without combustion of any kind. In front of me I have a fine platinum wire. In my hand I hold a wire that is in connection with a battery upstairs; the other wire in connection with the battery is attached to the far end of the fine platinum wire (Figs. 1 and 2). Now, when I make contact with the near end of the platinum wire, you observe that the wire is raised to redness, its temperature is high, and as I reduce the length of the platinum wire it gets brighter and brighter, the amount of electricity passing through it is greater and greater, and presently the wire is fused. I should have pointed out that as the quantity of heat generated in a wire increases, so does the colour of the light. When heat is applied to a body, that body is first warmed, then it gets gradually hotter and hotter, until it becomes red hot, and the first colour that appears is always red. The temperature is further raised, and the body assumes the colour of orange, then at a little higher temperature it appears yellow, and so the different colours of the rainbow are perceived according to the different temperatures to which the body tested with is raised. And now I want to show you the most intense form in which heat can be produced on this earth. There is no hotter object that we can obtain than that of the electric arc. I will try and produce this arc. You observe that when I bring these two pieces of carbon together a current of electricity passes between them, and the passage of the current of electricity between them creates such an intense temperature that a brilliant white light, as you see, is produced. Incandescent particles of carbon pass between the two points, forming a sort of bridge or arch, which is called the electric arc (Fig. 3). But the temperature of this arc is, as I said before, the highest temperature that we can produce; it has been measured, and is found to be 8,500° F. That is a temperature that can hardly be conceived; the melting point of iron is only about 1,200° F., the melting point of platinum, which is one of the most refractory metals we have, is about 3,000 F., but here in the arc we have the intense temperature that nothing can withstand, equal to 8,500 F. The colour is really due to the combustion that takes place between the materials forming the arc. I have just used two pieces of carbon, but I will now try other materials—copper, iron, and zinc. You will see a difference in the colour of the light, due to the fact that metal is burned in the arc instead of carbon. Every metal has its own distinct and particular colour, and the presence of the different metals can be detected by the character of the small arcs produced.

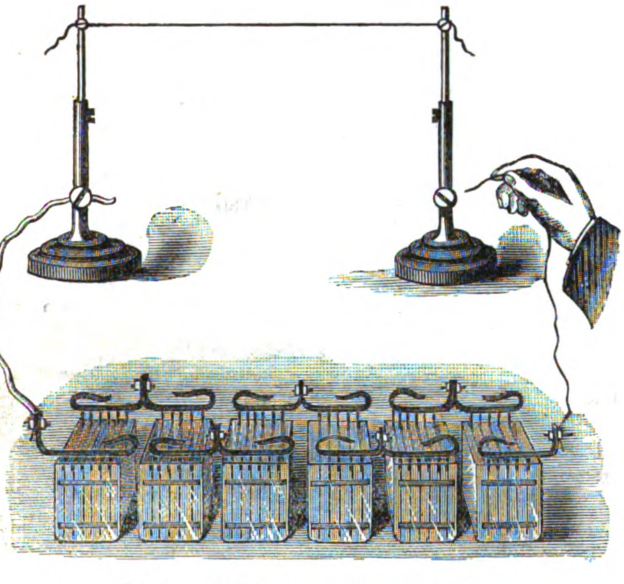

Fig. 1.—Fusion of Fine Platinum Wire.

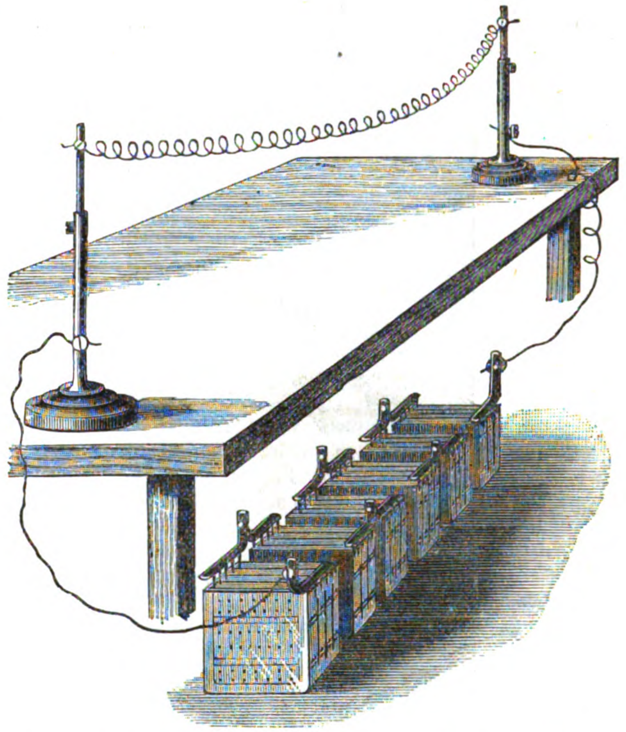

Fig. 2.—Heating and Expansion of Long Platinum Spiral.

I have shown you that we have two modes of producing intense heat, and therefore light, by electricity. I want now to show you how we produce electricity. The first essential for the production of electricity with a hand machine like this (Fig. 4) is a good dinner. The energy provided by beef or mutton enables the operator to turn the big wheel of the machine, whence motion is transmitted to the apparatus for producing the electricity. This machine when rotated causes a coil of copper wire to be whirled in a magnetic field, and that rotation of the coil in a magnetic field converts the energy derived from the grass and from the mutton through the machine into electric currents; those electric currents flow through wires that are under the table, they will appear in the two wires I hold in my hand, and will, I hope, reappear in the little glow-lamps I have before me in the shape of heat and then of light when I attach the wires. The light of the glow-lamp is of just the same form of energy as that which passed from the sun to the earth, and, by beginning backwards from the lamps we have

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light, heat, electric currents, mechanical motion, food or fuel in the shape of mutton, grass on the South Downs, to the sun. Whichever way it is taken you will find that there is direct action between the sun and the glow-lamp. The lamps are now burning, and you see that we are able to produce electricity to our hearts' content. Downstairs there is a gas engine; the gas engine is at work; the gas engine works because the gas supplies energy which, stored up in the bowels of the earth in the form of coal for ages and ages, has been extracted; it has been converted into gas at the large gasworks down the River Thames, it has been brought up here, it is burned in the gas engine, and produces energy in the gas engine exactly in the same way as the mutton or beef produced energy just now. There is a dynamo down-stairs exactly like the dynamo that we have upon the platform, and the current that is produced is exactly as the current we just obtained, and is sending electricity through all the lamps in this room. The currents of electricity passing through the lamps are producing intense heat, the heat is producing the incandescence of a fine carbon filament, such as I will show you directly, and the consequence is that we are now being lighted in this room by the energy that unmistakeably and undisputably arrived on this earth millions of years ago in the form of sunshine.

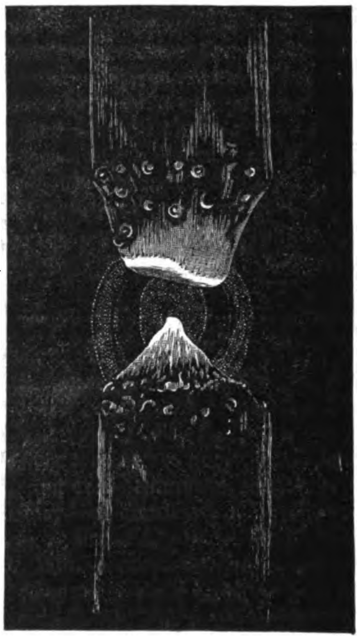

Fig. 3.—The Electric Arc (produced by Direct Current).

We can store up the energy in batteries. I shall show you to-night two or three different forms of battery. Here is what is called a primary battery. The only difference between a primary battery and a secondary battery is this: that a primary battery consists of chemical elements that at once combine and produce electricity by combustion, whereas a secondary battery involves some anterior electrical action, which prepares the surfaces of two bodies to put them in exactly the same condition as a primary battery. Here is a prmary battery known as the Schanschieff, which is charged with a solution of sulphate of mercury, and into that sulphate of mercury we will dip plates of zinc and plates of carbon. Zinc has a greater affinity for the sulphuric acid of the sulphate of mercury than mercury has; the sulphuric acid will at once combine with the zinc, it will burn the zinc just as the gas burned just now, but instead of burning with heat and light in the battery it burns in the form of electricity, which appears in the glow lamps attached. You see that the moment the zinc and carbons are placed in the cell electricity is produced, and the lamp is lighted. The form of battery from which we are drawing our electricity to-night is the accumulator, or the storage or secondary battery. The secondary battery simply consists of plates or "grids," as they are called, one filled with litharge, and the other with red lead; the one becomes pure lead, the other becomes peroxide of lead; the plates are combined in this form, and then placed in a glass cell; and upstairs there are 52 of these E.P.S. cells, which have been charged all day long by the gas engine of which I spoke, and which now contain a store of electricity that I shall make considerable use of to-night before I finish.

I showed you the form of electric light which we call the arc, and I have here to-night two or three different forms of arc lamps, which I will show in action (Fig. 5). But I want you to see this arc light for yourselves, and I want you to feel, as I feel, that in all nature there is nothing more wonderful and nothing more beautiful than the action of electric currents in the arc. The light is, as I attempted to show you, the very same light that came from the sun. I can show you that it is of the same character

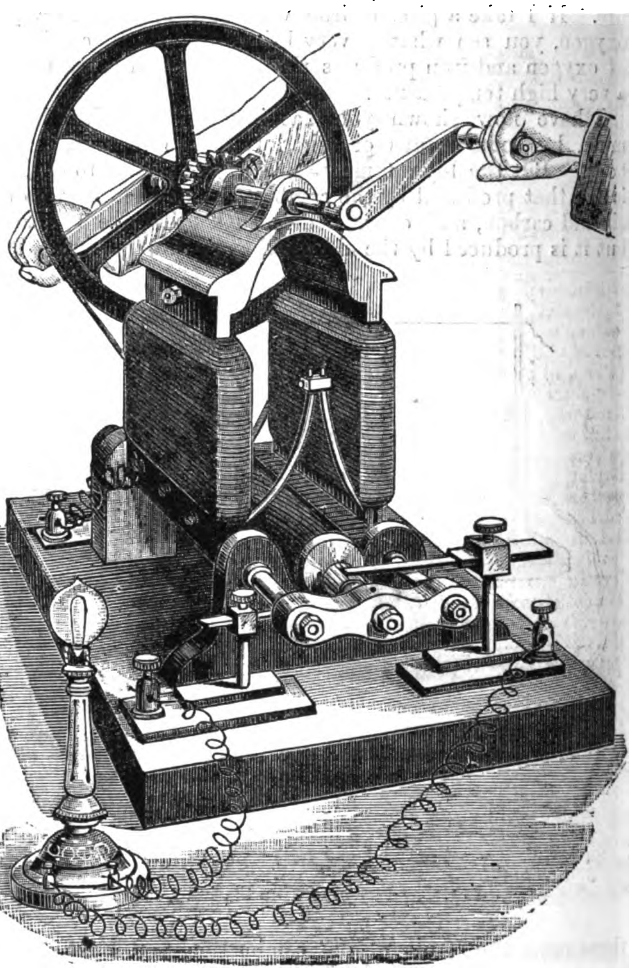

Fig. 4.—Producing Electric Light by the Hand Dynamo.

as the light of the sun, and in the lantern on the table there is an arc lamp the light of which we will throw on the paper before me in the form of a spectrum. There you see the spectrum in all its purity; the spectrum from the sun is no purer as regards light than what you now see. There you see all the colours of the rainbow, and I had intended, if it were possible, to show you in the first experiment, in which we raised platinum wire to incandescence, that the first colour would be the red, then the orange, then the yellow, then the green, then the blue, then the indigo, and lastly the violet. Beyond the violet there are rays of light which we cannot see; they are the rays that produce the photographic pictures, and, had time permitted it, we would probably have taken to-night a picture by means of the arc lamps, but it requires a long time to do so, and it really is no more interesting than an ordinary photographic picture. There are all the different colours of the rainbow. Those who are anxious to remember the order of the colours can very easily do so if they will remember this simple sentence, "Read over your good book in

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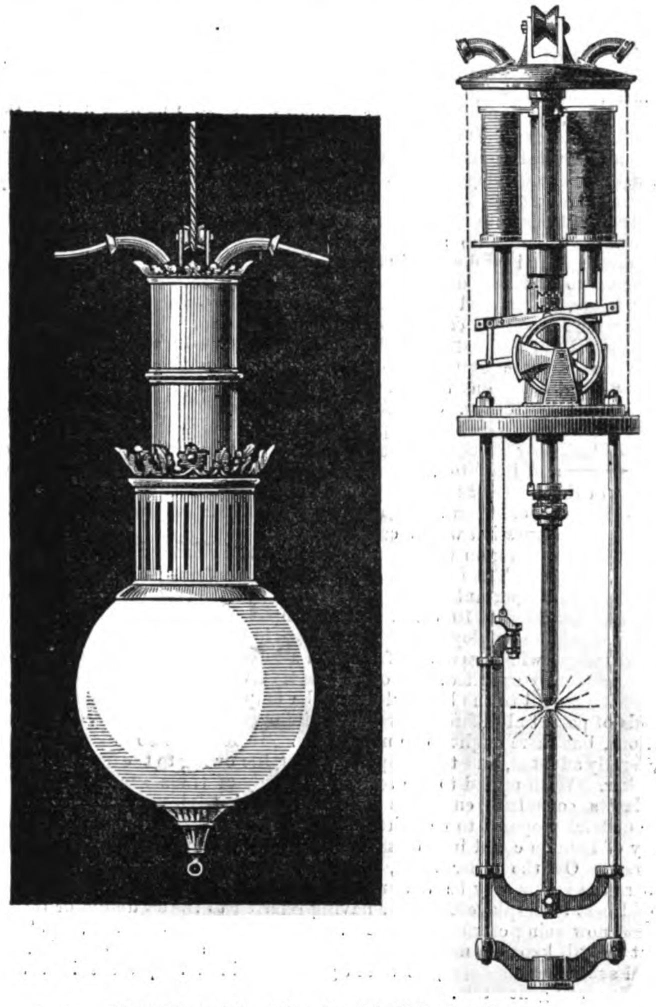
verse." The first letter of each word in that sentence gives the first letter of the colour in the order of the spectrum. It would be a very good thing if some of our artists were to study and remember the colours of the rainbow, for it is an extremely rare thing indeed to find a picture with the colours of the rainbow properly depicted; sometimes they are upside down, sometimes they are mixed; and if you discuss the fact with an artist,



FIGS. 5 and 6.—The Brockie-Pell Arc Lamp.

he will say, "I do not care about your science. I simply paint my own impressions."

(To be continued.)

REVIEWS.

Papers Literary, Scientific, &c., by the late Fleeming Jenkin, F.R.S., LL.D. Edited by SIDNEY COLVIN, M.A., and J. A. EWING, F.R.S., with a memoir by ROBERT LOUIS STEVENSON. Two Vols. (London: Longmans, Green and Co., 1887.)

It is impossible to glance over these volumes without some feeling of astonishment at the wide and varied range of subjects on which Jenkin's intellectual activity was expended. Greek Art and the Modern Stage, Political Economy and Technical Education, Submarine Telegraphy and Mechanical Engineering, Evolution and Sanitary Reform, may serve as samples of the contents. It is, of course, inevitable that in the discussion of so wide a range of subjects the Papers should prove of somewhat unequal value; yet it may safely be said that in them all the author displays keen insight and a remarkable degree of intellectual vigour. There is frequently also a peculiar suggestiveness which enforces the conviction that the essays are not merely the chance fruit of idle hours, but are due to the fact that the author had arrived at ideas to which he felt compelled to give utterance.

It is needless to say that Jenkin's scientific fame rests chiefly upon his contributions to the labours of that school to whom, a quarter of a century ago, under the leadership of Sir William Thomson, we owe the development of those principles and methods by which electrical phenomena were brought within the range of exact measurement. It was Fleeming Jenkin himself who first systematically employed in practical work that magnificent system of "absolute units" whose importance was first indicated in Germany by Gauss and Weber. His determination in absolute measurements of the specific resistance of gutta-percha for the Red Sea cable of 1859, is the earliest measurement of the kind on record. In a note by Sir William Thomson in the volume before us, Jenkin is also credited with having been the first to determine by experiment the value of the micro-farad, and it will further be remembered that he took an important part in the work of the British Association Committee on electrical standards.

It is therefore a good deal disappointing to find that in the present volumes only two of Jenkin's electrical papers are reproduced. We should like to have seen a reprint of the "Cantor Lectures" on Submarine Telegraphy, delivered in 1866, and one would think that at least a few of his British Association Papers might have been included. Prof. Ewing is no doubt able to give good reasons for their omission, but he can scarcely plead that they are of too technical a character after admitting such a Paper as that on "Graphical Methods," which is inadequately described as "somewhat abstruse." However, it would be ungracious not to express satisfaction at the inclusion of the essay on "Submarine Telegraphy," which first appeared in the *North British Review* in 1866. In this Paper, the graphic story of the early Atlantic Cables is told with much force and skill, and the scientific principles involved are set forth in a wonderfully clear and interesting form. A very considerable historical value attaches, moreover, to the article, as containing the record at first hand of one of the very greatest achievements in applied science, and one in which the writer himself bore a distinguished part. It is, we think, much to be wished that the electricians—and particularly the "electrical engineers"—of the present day were better acquainted with the nature of the difficulties encountered, and the measure of the triumph achieved by the engineers (as well as the electricians) who solved the problem of the Atlantic cable. It would then, perhaps, be perceived that even if the marriage of electricity and engineering was celebrated with the Gramme ring, yet their august betrothal was arranged with due solemnity at an earlier period, and was due to the men who stretched a cable from shore to shore of the Atlantic Ocean. The engineering and mathematical skill demanded for this task was certainly not less than that required for the design, let us say, of an "alternate-current transformer." Take, for instance, the purely mathematical problem of determining the strains upon a cable during submersion, of which the true solution was first given by Sir William Thomson in 1857. It will be a sufficient indication of the complexity of the problem to mention that the Astronomer-Royal was more than once misled in his investigations on the subject. We say nothing at this moment upon the electrical side of the question, simply because the achievements upon which Sir William Thomson, Willoughby Smith, Varley, and Jenkin himself, amongst others, built up their reputation must be familiar even to the "third-year student." But we do wish to enter a mild protest against the prevalent impression amongst the younger school that electricity had nothing to do with engineering until they took the thing in hand themselves.

In this essay Jenkin goes into most interesting detail upon the expeditions of 1865 and the following year, and describes the various improvements, both in the manufacture of the cable, the methods of testing, and the equipment of the vessels, which distinguished the successful expedition of 1866 from that of the previous year.

But how much, after all, this success was really due, not to the perfection of the machinery employed but to the men who

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handled it, the following extract may serve in some measure to show. Something had gone wrong in one of the cable tanks, several bights came up together, and in a moment it was seen that "five cables were running out from the tank instead " of one. These were carried aft together till they were stopped " by the paying-out machinery; when in a very short time " they appeared like the tangle of a gigantic fishing line. The " ship was immediately stopped; but the night was pitch " dark, rain falling heavily, and a fresh breeze blowing, the " cable over the ship's stem being only visible by a slight " phosphorescent light where it dipped into the water. Sir " James Anderson, however, by great skill, contrived so to " handle his ship of 23,000 tons, which was riding at single " anchor in 2,000 fathoms, by a mere thread, that the engi- " neers and sailors had time to reduce this apparent confusion " to order, and in about three hours the paying out was re- " sumed without the perfect testing of the cable having been " in the slightest degree interfered with."

The limits of our space will scarcely allow us to notice the valuable memoir by Robert Louis Stevenson at such length as its importance demands. The earlier half of Jenkin's life—from his boyhood till, in middle age, he settled down at Edinburgh—was full of picturesque incidents, and not even wanting in exciting adventure; and with all such passages as these it needs not to say that the biographer is in fullest sympathy, and brings to bear his choicest literary skill. In 1848 Jenkin was at school in Paris, and managed to see a good deal of the fighting in the streets. He then removed with his father and mother to Genoa, where the family arrived just in time to witness scenes of quite as stirring a character as those they had fled away from. In later days the love of activity and adventure which was thus stimulated in Jenkin was pretty fully gratified during his engagements on the various submarine cable expeditions—a task upon which, with some intermissions, he was occupied from 1858 to 1873. This part of the story is told chiefly by means of extracts from Jenkin's diaries and letters, although they are only of a fragmentary description.

After all, notwithstanding the grace of style and the sincere admiration displayed by the biographer, we could wish that at least the later chapters had been written by some one of his Edinburgh friends or colleagues who would have been more in sympathy with the scientific side of Jenkin's character. Mr. Stevenson does not hesitate to express his own distaste for applied science. On the whole we could also have spared some incidents of doubtful interpretation (in one of which Mr. Stevenson himself figures as an Edinburgh student), and the value of the work as affording a means of estimating Jenkin's true position in the roll of scientific fame would rather have gained than lost. We may bring to a close this necessarily meagre notice of a work which, in spite of the omissions we have deplored, is deeply interesting from beginning to end, by the following extract descriptive of what the biographer terms "his (Jenkin's) rarest quality":—"Fleeming would never suffer you to think that " you were living, if there were not somewhere in your life " some touch of heroism to do or to endure. . . . He loved " the harsh voice of duty like a call to battle. He loved courage, " enterprise, brave natures, a brave word, an ugly virtue—every- " thing that lifts us above the table where we eat or the bed " we sleep upon. . . . [Nevertheless] he loved the comedy " which shows a hero human, and yet leaves him a hero; and " the laughter which does not lessen love."

Telegraphs in Anam.—A line of telegraphs, about 1,000 miles in length, connecting Saigon with Hanoi, was opened for service on the 21st March. There are 26 intermediate stations.

Indian Telegraphs.—The *Indian Engineer* says that the telegraph line from Ghoom Station, four miles from Darjeeling, has been laid to within a short distance of Kalimpong, the wire being run from tree to tree through the forest. The line should reach Padoung by the 15th prox. The work is proceeding at the rate of eight miles a day.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

CENTRAL STATION LIGHTING.—TRANSFORMERS v. ACCUMULATORS.

(*Continuation of Discussion on Mr. Crompton's Paper from page 657.*)

THURSDAY, APRIL 19TH.

Mr. PREECE, in continuing his speech commenced at the previous meeting, recapitulated the three principal arguments in favour of batteries, namely, the convenience of storage, the utilisation of the current for motor purposes, and the fact that a small plant could be used during the whole of the day. He then pointed out that, on the other hand, there were also several arguments in favour of transformers, viz., that a higher E.M.F. can be employed, and therefore a smaller current in the distributing mains; that transformers are simple in construction, and can be easily stored away in odd corners, or, as Mr. Kapp suggested, below the pavement, and that no supervision is required; and that the efficiency of transformers is undoubtedly much higher than that of batteries. With reference to the load diagrams for electric lighting during the twenty-four hours, he pointed out that it was necessary in any case to provide energy for the period corresponding to the high points of the diagram, and that it did not matter much whether the capital was expended in the purchase of more batteries or in providing additional engine-power. Electric lighting on the transformer system had been successfully carried out by Messrs. Gaulard and Gibbs at the Grosvenor Gallery installation, which had been a pioneer for electric lighting in this country. The transformer system had also been used with favourable results at Eastbourne and Brighton, largely on the Continent, and to a still greater extent in the United States. With reference to Mr. Crompton's remarks as to the waste of steam in the secondary generator system, he considered this to be a question which concerned the engineering principle adopted rather than bearing on the question whether transformers or accumulators should be used. The loss took place in the engine room and not in transforming. An important question not raised by Mr. Crompton in his Paper was whether 30-watt 10 candle-power lamps or 60-watt 16 candle-power lamps should be employed. He himself was in favour of the smaller candle-power lamps, which gave satisfaction in all cases where the others had not been previously supplied. Another question which should be considered was with regard to the best voltage to be employed. In this country all kinds of potential differences were used indiscriminately in different installations, but there ought to be uniformity. In America 50 volts had been generally adopted, and the lamp had a long life owing to the filament being thicker. With regard to the relative economy of transformers and accumulators, consulting engineers had to base their advice on the nature of the district proposed to be lighted. A compact neighbourhood such as the City of London could best be served by the Hopkinson-Edison three-wire system. On the other hand, for a scattered district like Wimbledon, where the mains may be ten or twelve miles long, secondary generators could best be employed. After having referred to the accumulator installation now being carried out by Mr. J. H. Gordon at Whitehall, he stated that he still kept his mind open on the subject of secondary batteries, but until success was assured, he would give his opinion at present in favour of secondary generators.

Sir DAVID SALOMONS said he believed Tallyrand had remarked that every man ought to leave a son, plant a tree, and write a book. He had had the good fortune of having done all three, and it was the third, the book, which only interested them at that meeting. He merely mentioned this because he did not wish to advertise his views. He would like, to begin with, to criticise Mr. Crompton's figures. In the first place, he completely approved of Mr. Crompton's plan. Mr. Kapp on the last occasion took objection to the figures at which the accumulators could be produced. He himself had referred to a large number of notes from manufacturers and others on experiments he had made at home, and he felt sure that the figures were quite within the mark. He was very pleased to see that Mr. Parker, who spoke at the last meeting, also agreed with these figures, and that the price put—he thought it was £16 per kilowatt—was not at all an unreasonable one. He thought the efficiency placed at 60 per cent. was too low, and 70 per cent. might fairly be taken as a reasonable amount. Mr. Preece spoke of the paste falling at the rate of one pound a year—that is to say, after two years it weighed two pounds. He thought that was very high. He had been looking at some old cells since the last meeting, and he found that after eleven months there was not one ounce lost, and in the case of some old ones that he had got, there was not so much as a pound after three or four years, so that the probability of their lasting long was far greater than people imagined now that their constitution was being understood, and the old idea of undercharge was now completely reversed, and overcharging was the rule. One thing he wanted to call their attention to which Mr. Crompton seemed to have overlooked. He showed them a current curve, which was probably approximately correct, but he entirely overlooked that the day would come when motors would be used in every house, and that curve would be completely altered, and the output would be double or treble, because he foresaw that motors would take a great deal more current than lamps in the course of time, and that would alter the estimates very considerably. He would also refer to a point which had occurred bearing on Mr. Crompton's Paper: it was that of the absolute necessity, if they used the batteries as distributing stations, that they must be put two or more in parallel. In order to prevent absolutely a break down, he altered the installation at home from a very large series battery to two in parallel, so as to have

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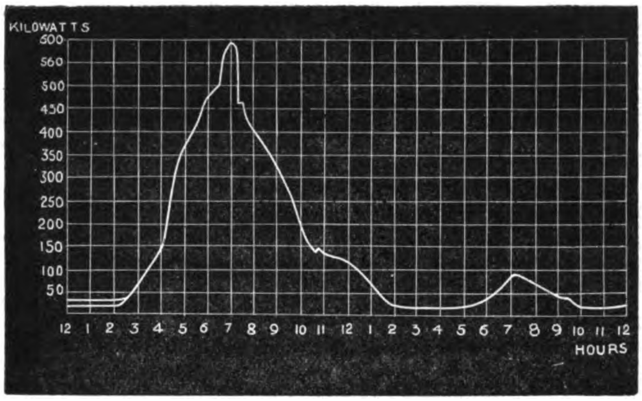
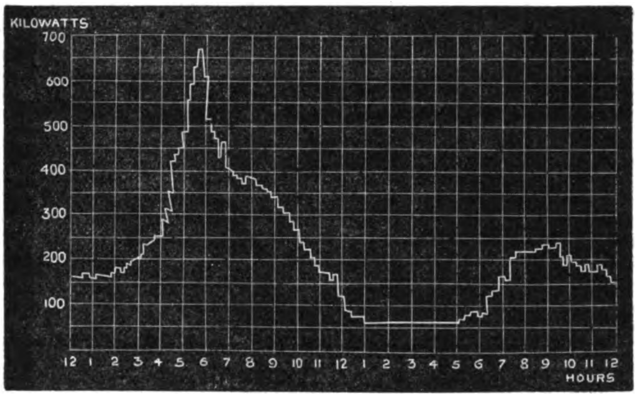
the advantage that if anything was wrong with one battery the other should be working. An accident occurred which might occur to anybody, and which proved the advantage of the two batteries. By some reason or other, in the morning, on entering the battery room, one of the glass cells (and it might happen of course to a cement box, or a lead box, or any kind of cell) had broken, and the acid had run away. That battery was completely cut out. If he had depended on a one-series battery it was perfectly evident that there would have been a break-down, notwithstanding the great talk about the certainty of accumulators *versus* all other methods (hear, hear). He mentioned that so that in future it might be discounted.

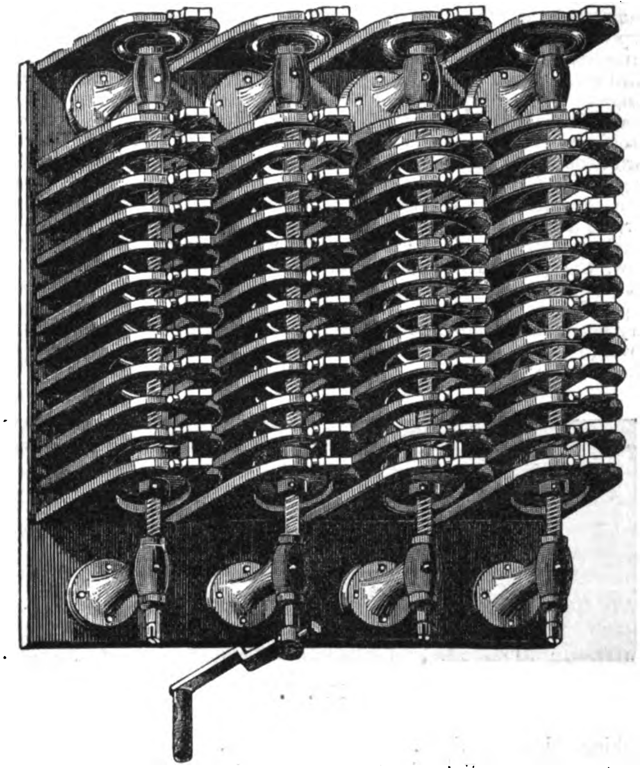
Mr. CROMPTON referred to some points touched upon by previous speakers. He said the regulation of groups of batteries placed in series was the simplest thing possible, and it had been carried out most successfully in Vienna. There had never been the least hitch since the commencement, and there was no loss whatever in regulation. The diagram on the wall (Fig. 3) represented three battery stations arranged in series. They might suppose a current entering the right-hand lower corner, and passing through the first battery, with the lamps parallel to it, passing away from the end of the first battery to the second, also through lamps in parallel, and so from the second to the third, and the third to the fourth. As to the means that he used for keeping the potential constant in those lamps, he had not yet pretended in these stations to use automatic regulation; but there was not the least difficulty in using automatic regulation. The main idea was to have a certain number of cells which could be connected either in series or else in parallel amongst themselves, and then in series with the rest of the battery. When it was required to increase the potential at the lamp terminals, one or more of these cells could be taken out of parallel and placed in series with the rest, and the lamp connection was at the same time shifted back to this point. That had been done by the apparatus on the table (Fig. 4). This switch had been at work for a year at Kensington Court, and it had worked perfectly satisfactorily. They placed the cable direct on to the fixed contact and passed the current through it into one of the ring contacts by means of the wheel, each ring contact being connected to a cell; or they could in large installations do it with a double ring such as those on the table—that was to say, he had one for the current entering the battery, and the other for going away to the lamps. The reason he had two was because under certain circumstances it might be advisable in fitting up a battery to be putting in current to a higher number of cells than they wished to take out from. That only occurred at certain intervals of time, and was not the usual condition of affairs. There was no loss whatever in connection with this method of using the battery, and such losses as took place were only at such times as the battery was discharging, or when the battery was too full, and that could only occur by the neglect of the attendant in charge. They would see that an apparatus of this kind lent itself to automatic regulation. But as hitherto they had had to keep a man in the battery station for other purposes—that was to look after the batteries at the large stations—that man might as well be employed as not. The changes that took place in the course of the evening were not very frequent ones, and the regulation was affected without difficuly. The apparatus had worked perfectly successfully at Vienna for nearly ten months without any hitch from beginning to end; and the same apparatus had worked at Kensington Court perfectly successfully. People were asking why he was not showing the Howell batteries. Everybody ought to know if they did not that Kensington Court had been worked entirely by Howell batteries for a year and three months, and he had never refused anybody who asked permission to see them; and anybody who wanted to see them, whether a

Load Diagram, London.



Load Diagram, Cincinnati.





FIGS. 1, 2, and 4. (Diagrams 1 and 2 were exhibited by Mr. Crompton on the first night of the discussion.)

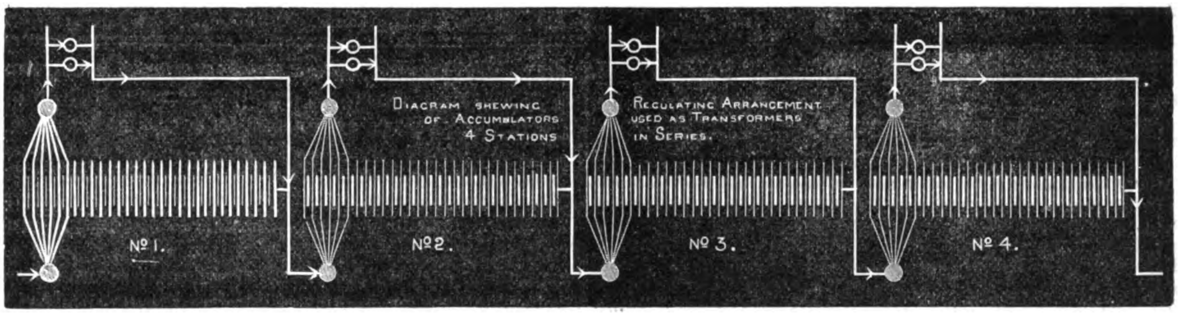


FIG. 3.

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rival or a friend, was welcome to do so. It was therefore not quite fair to say they were invisible. The Howell batteries were there to be seen, and the largest installations that had ever been attempted were with Howell batteries (applause).

Mr. SWINBURNE thanked Mr. Crompton for his Paper, which was valuable because its data were based on practical engineering, and were not obtained simply by estimating in the office. On the question of alternating machines Mr. Crompton seemed rather sceptical about coupling in parallel. The question of employing alternating machines in parallel could not be discussed generally—it depended entirely on the alternating machines. Some forms could not be coupled in parallel, such as the Ferranti machines. Other machines would go in parallel perfectly, and would stand very large variations of load without getting out of step. The Westinghouse was about the medium, and the Westinghouse ran very well in parallel. There was a diagram on the wall in which he showed a method of saving the machines from getting out of step, if they had not been constructed quite properly. The rings marked A, A, A, A represented alternating-current machines. There were switches to each, and the top line and the bottom line were mains. The first machine was simply put right on the main, the second machine worked through a thing like a transformer, and the wires were so arranged that when it was perfectly in step with machine No. 1 the transformer was not magnetised at all, but immediately it began to get out of step the transformer stopped it. The third machine was put on in the same way, the transformer being specially designed by the proportions of the wire on each to work properly under these circumstances. By that means they could put any number of machines—even Ferranti machines—in parallel, and work with very large variations of load, and they might shut the steam off the engine without putting it out of step. The question of getting the machines in step to start with, of course, was a very simple one, and a great many little dodges for the purpose had been brought out, especially in America. It was such a very simple matter that it was not worth while going into it any further. Now, the problem of running alternate-current motors, once they had got them started, was very nearly the same as running the dynamos in step with varying loads, except that the variation of load was, so to speak, very much more important. He had shown therefore in the diagram a motor (M) which was supposed to be driven off the mains. It was provided with a regulator which was simply what Mr. Gordon called a

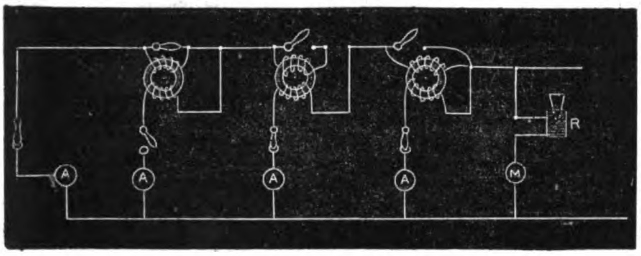

FIG. 5.

choking coil, except that the core was movable. Directly the load came on that motor it would begin to get out of step. Immediately that happened, the core of the choking coil was pulled down against the opposing spring, and that stopped the tendency at once, he thought. He believed in that way they could make a motor that could work fairly efficiently over large differences of load. As to the starting of motors, he did not believe any difficulty really existed. There were many ways of designing motors which were self-exciting and started themselves. One very simple way was to make the exciter itself with a laminated field. It was a doubtful sort of thing, but there was no reason why it should not be done. They might start the whole by passing some of the current through the exciter until they had got up speed, and then switch over suddenly. The reason why motors were not made just like direct-current dynamos with laminated fields was that their motors would have to be very large to meet a given output. That was the only objection to it. As to the transformers, a great deal had been said about testing their efficiency. He not think that it was really a point whether they lost 1 per cent. of their power in the transformer or 2 per cent. The point of importance was that they wanted their lamps to run at the same electromotive force, and they could not make the alternating-current transformer compound up, but they could make a dynamo compound up for varying lights. He believed, however, that there was no difficulty in making the alternating dynamos really to compound up without altering the field. It was a very curious thing; but it seemed quite possible. In fact, they were making a dynamo at Mr. Crompton's works which he hoped would do this. The mean volts fell off when the current increased, but the virtual volts rose, because the curve was steeper towards the end. As to the insulation, he did not think they had any very clear data as to the effect of alternating currents. He did not think it at all followed that they must have the same insulation with alternating currents. It was quite possible that the insulation that might break down under 2,000 volts in one direction would not break down under rapid reversals. Mr. Crompton's difficulty, he thought, would be his introducing 400 or 500 volts into the houses. He was afraid that would be a great drawback. As to the accumulators, he did not know quite what to say. He would rather like to quote Mr. Mordey's dictum—"That the great advantage of an alternating-current system is that people cannot go and put batteries on it" (laughter). It must be remembered that in discussing the question of alternating machines they had been making direct-current machines on scientific principles for some years, and they were only just beginning to do it with the alternating current. Even now alternating-current machines could be made to run at quite slow speeds, giving an efficient of about 98 per cent., and he believed commercially about 95. He thought they would be found later on very much cheaper machines than direct machines. That must be very carefully borne in mind. Returning to Mr. Crompton's scheme, he could not help thinking that the real solution of that problem lay not in taking 400 or 500 volts, but in the use of what one might term dynamotors, or motor generators. They would have the doubtful advantage of being able to use accumulators, but they would have several other advantages. They could do everything they wanted with alternate currents, except that they had to look after a pair of brushes; but if they wore working at local stations they had a man to look after the accumulators, and it was nothing for him to look after the brushes. These dynamotors had some properties that had not been realised. Dynamotors could be made to compound in the secondary circuit, even with a varying electromotive force in the primary. They could vary their electromotive force in the primary if they had changes in the load, without interfering with the secondary. This might not be so very important when they were working the sub-stations, but if they were working a large building direct it became very important. They might also charge batteries in their local stations on the primary circuit, and run the dynamotor on the discharge; he did not know whether that would be an economical thing to do.

General WEBBER said the one point to which he wished to draw their attention was the system by which Mr. Crompton proposed to lay down underground conductors. Mr. Crompton proposed to make subways with an interior cross section of about two superficial feet, and he proposed to suspend from the roof of that subway insulators to carry his bare conductor. He did not know whether the construction of this subway included any system of making it water-tight; but he could hardly conceive that that would be possible. Brick walls and concrete floor and flagging to cover would certainly not be, in any sense of the word, water-tight. Now, he could readily believe that for the first year or two years not much trouble as regarded the insulation of the conductor would arise. He had seen a good deal of underground work, having inspected a very large number of sewers and subways; and he felt sure before two years had elapsed Mr. Crompton's conductors and their insulators would be covered by detritus of various kinds. The brickwork and the sides of his subway would begin to wear away; the coverings of the floors would probably leak extensively; and in various ways Mr. Crompton's subways would arrive at such a state that the insulation would disappear. Again, they could readily imagine that those nice little roads under the footway would become a sort of "Rotten Row" for a large population of rats and their families—(laughter)—all adding to this condition which he believed would arise. It was understood that there was no means of obtaining access except at the connection boxes to any part of it without taking up the roadway. Under these circumstances he believed that it would be well if electrical engineers would look to the many years' experience of the telegraph companies, who spent large sums of money in laying down conductors which they had to take up from the beginning to the end. He had been engaged, amongst others, in doing a great deal of that work, and had arrived at the conclusion with regard to the maintenance of underground conductors, that it was only possible as a matter of maintenance when they could be withdrawn at pleasure. The drawing-in system was so well understood that he need not enlarge upon it in any way. Its advantages were perfectly evident to every engineer. As regarded a few of Mr. Crompton's calculations, he would like to make one or two remarks. That gentleman met them by a most clinching argument in favour of all his calculations, namely, that he would always do the work for the money. That was a very good and a very sound argument, and he thought that when Mr. Crompton estimated his means of distribution on the large scale, they must all feel that, from the point of view of the proportion it presented to the total, Mr. Crompton was not extravagant, particularly when they knew that the London Hydraulic Power Company found little difficulty in obtaining capital for the distribution of motive-power on a system which was infinitely more costly in every way. Mr. Crompton allowed 20 yards of main for every house, or 20,000 for a thousand houses. He thought that was susceptible of a slight correction. It was a very good thing to find an estimate laid before them with so large a margin, but anything that would reduce it would be an encouragement to investors, and in a district with which he was particularly well acquainted he had found that where the roads were wide—the frontages of the houses palatial to some extent—it was certainly well within 17 yards; of course that would reduce his 20,000 to 17,000. This brought him to the main feature of the economy which Mr. Crompton pointed out to them, and which he considered no doubt a very tempting bait in connection with the system of subways which he proposed. That was the saving which he made in insulation. It was not clear, without knowing the details of Mr. Crompton's calculations, what he included in those figures, but he would draw attention to the examples in which the cross-sectional area of the copper was half an inch. In one case Mr. Crompton made an insulation cost £35. 17s., whereas in the other example he gave (that was his own subway) it was only 4s. 6d. The latter was a very attractive figure, but it was not quite a safe one, he thought, because if 4s. 6d. was too small £35. 17s. was certainly too large. He gave the cost of copper in that instance as £54. 12s. for the whole, which divided by two made £27. 6s. for the 100 yards. It would be very evident to those who had gone into the figures that this figure should not exceed £22. That brought him to the question of the system compared with Mr. Crompton's, and as his own name had been connected with it, he might be allowed to say a few words upon that point. Person-

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ally his interests in it were purely of a scientific character as an engineer, and his opportunities of trying it had been entirely due to his connection with the Anglo-American Brush Corporation, in whose yard, at the Borough-road, it was tried and upon exhibition for six months. The use of the bitumen concrete, he was glad to say, had been adopted to a certain extent by Mr. Crompton in his installation at Kensington Court, because he thought that every instance in which it got fair play and was properly used would bring to the front several of its conditions which were invaluable. Essentially it was a system of being able to withdraw the conductors when desirable without taking up the footway. Whether that would succeed or not the experience of those who had withdrawn cables which he believed were much more difficult to withdraw—namely, the telegraph wires—would go far to prove. The bitumen conduct could be bent with great facility on the spot, so as to meet all the varying conditions which might occur. If they took the City of London as an example, he might safely say that it was utterly impossible for Mr. Crompton's subway to be put down. Mr. Callender and Mr. Butler had been good enough to make for him the following tests, showing the breaking strains, crushing weights, specific gravity, and other data, connected with the bitumen concrete casing. The first test was made with a case 6 ft. in length, supported at two points 3 ft. apart, and weighted in the middle. The first indication of strain appeared with a load of 2,124 lbs.; and the breaking strain was in different cases 2,306 lbs., 2,130 lbs., and 2,457 lbs. respectively. A six-way case, 5½ in. by 8 in. square, with 2-in. ways, was also broken; the fracture was sharp and clear, and the channels were not disturbed. This was at a temperature of 50° F. Another six-way case was placed under a crushing weight of five tons without being affected. A 6-in. cube of the material was subjected to a crushing strain of eight tons without effect. These results, he felt sure, would be a very great encourangement to the future use of this arrangement (applause).

After a few remarks from Mr. SIDNEY WALKER,

Mr. HAMMOND said that he had very much pleasure in responding to the Chairman's invitation to tell them something about Eastbourne, especially upon the point which had been raised by Mr. Crompton in his Paper, and which had been commented upon by the other speakers. He considered that the question which had been raised by Mr. Crompton was the one crucial question which confronted all those who had to do with central station work. It not only confronted them at present, but it was one which some of them had had to deal with in the immediate past. Eastbourne had been mentioned, and he might say in connection with that installation that some two years ago they had to light the Town Hall. The problem was to put some three hundred lights into the Town Hall at Eastbourne on the condition that any number of the lights could be turned out at any time, with ten, twenty, or thirty left burning in the committee rooms or the whole three hundred burning at once. Under the conditions that they were then working, *i.e.*, the group system, it became impossible to carry it out on the plans then in vogue. They then had to consider whether it was best to place batteries into the Town Hall, and charge with a high tension current, or to put in converters or transformers. Two years ago, as the members of the Society knew well, the choice of transformers was very much limited; and having carefully considered the question, and having decided upon the transformers, their engineer, Mr. Lowrie, had to practically make his own transformer, but with this result, that the installation in the Town Hall at Eastbourne was, though he "said it who should not," the one thing that English electricians could look upon with great pride. All those who knew the installation at Eastbourne, and who had visited it, had seen that they had been able by means of transformers to solve the problem perfectly. On reading Mr. Crompton's Paper he was distressed to find that on the first page, when he looked about for facts and figures, the first fact with which Mr. Crompton enlightened them was that the installations at Eastbourne (where they had been working for some six or seven years) and at Brighton (where Mr. Arthur Wright's hard work as managing director in everything connected with the place was well known to many of them) were characterised not as honest attempts to carry out permanent lighting, but as "confessedly carried out in a temporary manner for the purpose of popularising the electric light and inspiring the confidence of the public in electrical supply as a form of investment" (laughter). This in a scientific paper surprised him, because, if during the last five or six years he had struggled for anything it had been to pay a dividend to those who had invested their money in the Eastbourne and Brighton Companies; and their last balance-sheet at Brighton, issued some six weeks ago, had passed through the crucial test of being passed by one of their largest shareholders, known to be one of the best accountants living. He could not help thinking this was a piece of unkindness, because Mr. Crompton also made use of words to this effect. He said, "It was hardly to be wondered at that what little knowledge exists on this subject should be confined to the few who have lighting stations under their immediate charge;" and yet in the next paragraph he said, "Do not take any notice of Eastbourne, they have only been carrying out a central station there for some six or seven years; do not take any notice of Brighton, which is begun upon a very small basis, and been getting gradually larger and larger;" and, in fact, Mr. Crompton said, "Do not take any notice of the Grosvenor Gallery, because they are only a set of advertisers" (laughter). That being so, he presumed that Mr. Crompton had himself taken no notice of them. Therefore, if he might trespass upon their time for about five minutes, he would tell them one or two facts connected with these two central stations which he did not think they would gather from Mr. Crompton in his reply. In the first place, they were working with transformers at Eastbourne, and on the direct system at both places. It was true they were working on a small scale, with some 1,500 or 2,500 to 3,000 lights, but he had learnt at Brighton that to start a central station one has to be contented with doing scattered lighting, and to gradually add fifty or a hundred lights at a time. At Brighton they had one of the hardest-working men and one of the most scientific men in England in charge, and yet, in spite of all that, they were only gradually obtaining little additions from time to time. Mr. Crompton said of the transformer system, that you had only to look at his load diagram to see the absurdity of it. Being about to put down a central station in London not very far from Mr. Crompton's Kensington Court station, he had had to weigh the question over again as to whether the transformer system or the battery system was the better, and he had again come to the conclusion that the transformer system was the better. Mr. Preece, in his speech, gave them a hint which he wished to enforce, and it was this. Mr. Crompton said in his Paper that of course in a transformer station you must have three complete shifts of men. He (Mr. Hammond) was at Brighton last night, where the current was supplied to customers the whole of the 24 hours; he was there at the busiest time, when the light was fully on, when every stitch was going, and he was there till late, when he saw one engine after another put down and down until there was only one engine running, and he was able to say that the labour that was being expended in Brighton was absolutely proportional to the load that was going on in the circuit. There were no full shifts of men. On leaving Brighton that morning, he called at the station, but did he find the same number of men working there as he saw last night? No, not at all; he only found two men working. To say that under the transformer system it is necessary to have three times your normal staff, is the talk of people who would know very much more of the subject if they went down to Brighton and Eastbourne and observed it actually in practice (applause). Therefore he said with regard to the question of economy in working a central station, Mr. Crompton must be as far wrong in the facts and figures relating to it as he was upon the motives that were inspiring and had inspired them for five or six years. Mr. Crompton was also as wrong as to the way a transformer station was to be carried out as he was upon the other thing of which he spoke. He came that night to listen to this scientific man and to get inspiration from him. It was just at the moment when the order had not been given out for the first London station of the House-to-House Company, and if Mr. Crompton could convince him and his directors that his system was the best plan he would be willing to adopt it. At Eastbourne they were working entirely with transformers, and at Brighton they were working with a direct system, the transformers being gradually put on to it. The next point was reliability. They were told by the last speaker that under a battery system they were perfectly comfortable. Now where did the reliability come in in a battery system? What was the reserve of force upon which they could rely for continuity of lighting? They had a chemical and electrical storage—that was their reserve. Speaking in that room, with many civil engineers around him, he asked which was the better to rely upon—whether it was that chemical reserve or a mechanical reserve which could be thrown on at any moment? He ventured again to appeal to experience, because Mr. Crompton had chosen to sweep away all outside experience. At Brighton one engine was always ready in reserve. If the burden of work was sufficient to occupy only one engine, then only one engine was doing the work; but there was a second engine ready with the steam up. Mr. Crompton spoke of a supposititious engine, which apparently was liable to suddenly burst right up into the air without giving the slightest intimation (laughter). His own experience of engines was this. They had heard from Mr. Swinburne of a nice little arrangement that rang a bell in order to tell you that something was wrong. And so with engines: if they did not absolutely get up and ring a bell (renewed laughter), there was always a little leakage by which the practical eye of the man who is in charge of the engine shows there is something going wrong. His engine always gave notice if there was something wrong in its inside; there were oceans of time if they wanted to throw on a second engine (laughter). They had never at Brighton been so taken by surprise that they had had a stoppage of a continuity of light, or any instance of not being able to rely upon their reserve force. He therefore held, as the only perfect method of having reliability and continuous running, that they must have their reserve in engine-power ready to put it on at any moment, and they must not put into the circuit these wretched accumulators. Undoubtedly, if there was one portion of their central lighting station at Brighton that they were afraid of, that was where the accumulators were in use, for they had a few in private houses, which enabled them to compare the two systems. In practice they found that instead of giving the efficiency that Mr. Compton claimed, they only got an actual efficiency of 60 per cent. Mr. Crompton, in making up the figures, said 80 per cent. was the output of a perfect accumulator. His company had found from experience that that was not so—that it was 60 per cent. Many gentlemen present would confirm those figures. What does Mr. Crompton say with regard to efficiency? He said that when the station work was going at pretty full swing they got about 70 per cent. efficiency in the converters. He could only suppose that Mr. Crompton had not yet seen an efficient converter. A battery which gave an 80 per cent. efficiency must be an extraordinary battery; but the converter which is content to give a 70 per cent. efficiency at full load must be an atrociously bad one. He could take Mr. Crompton down to Eastbourne, or anyone else who was interested, and show them converters working at 95 per cent. efficiency. There was only one point more, and that was this. Their experience at Eastbourne was dead against Mr. Crompton's figure of having to put aside 10 per cent. depreciation on converters. What is the wear and tear on a converter, say in comparison to that on a dynamo? They did not take off 10 per cent. depreciation on dynamos. They had at Brighton some of the Brush dynamos that were first put in there that had cost them only 33s. or 34s. a year for repairs; probably Mr. Wright would be able to give the exact figures. They did not put 10 per cent. depreciation aside even for that; but this silent, quiet thing that was doing no active work, that had no moving parts and no chemical arrangements to get out of order, why put aside 10 per cent. depreciation on it, and only put aside 15 per cent. depreciation on the accumulators? He said on these points the experience which Mr.

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Crompton had brushed aside was dead against him on the four points of economy of load, reliability, efficiency and depreciation. A stranger would suppose, on reading the first paragraph in the Paper, that the Eastbourne system was an overhead system. Mr. Crompton spoke of "Eastbourne, Brighton, and, in fact, all overhead systems." Eastbourne was an underground system. The last speaker had said that the insulation would break down as soon as they attempted to pass 2,000 volts through the cables. At Eastbourne they had some seven miles of mains, they were underground; they did pass 2,000 volts through (that was their charging current), and they lived through it all (laughter). They relied on underground-working; they made careful tests of it, of course, but they found no difficulty about it, and he was astonished that, in the face of the absolute experience at hand in a place within arm's reach, it should be said that the great thing against the transformer system was that it necessitated such a high current as 2,000 volts. He must say that on examining closely into the four or five leading facts in the Paper which he was able to check by absolute experience of lighting stations—small though those places were, though growing daily—he did not place much confidence in Mr. Crompton's conclusions (loud applause).

Mr. A. P. TROTTER: Mr. Crompton has, I think, rather shaken the faith of a good many of those who rely on transformers as the system of the future; many of us feel that he has thrown quite a different light on the matter, and I for one should not like to say that batteries will not be part of that system. But there are several points which have already been raised which show that the time has perhaps hardly come for this. I do not know if the diagrams on the wall represent a station where motors are being used,* but as has already been pointed out, if motors are used, the daily consumption will certainly be as high, if not higher, than what we see on the diagrams. Perhaps one of the most serious objections to batteries is that of their efficiency and their life; but when the time comes for battery makers to give an absolute guarantee, and to undertake to repair and to keep in order, without stopping the current, the batteries which they supply, for a sum of say 10 to 12 per cent., we shall be in a very different position. People will hardly like to sink so much money as Mr. Crompton recommends upon batteries, judging from the experience that we have had during the last three years. As to the efficiency, we know that 60 per cent. is about the usual thing for a battery which is at one time charged and at another discharged. Mr. Crompton has given us a very different figure, viz., 80 per cent., and I hope in his reply he will explain if it is due to the short length of time during which he is really discharging from his battery that this very high efficiency is obtained. The question of reserve has already been discussed, and it seems much better to have separate engines and dynamos than a battery reserve, unless two sets are used, and then no doubt troubles arise and there is the double expense. If you have six dynamos of 100 kilowatts each, you always have one or two of them with the steam up, and either just ready to start or having lately stopped, and, except at the short time of full load, you will always have the opportunity of turning another one on within a few seconds, and even at the full load there should be at least one in reserve. It is most discreditable to this country that at the present time there are so few installations with a single dynamo and engine in reserve at the time of full load, and perhaps as much harm has been done to electric lighting on account of the absence of such a reserve as from any other reason. In the case of waterworks where they have perhaps two engines to do the ordinary work and three for the full load, there is always one in reserve, and in a central lighting station with six or eight 100 electric kilowatt dynamos, with one in reserve, there will be ample time for overhauling and repairs. I would like to ask Mr. Crompton why he has put down 60 volts for the lamps at the transformer station. It makes some little difference to the calculation; but what is more important in working out the comparison is, that he has assumed that two out of every three houses will, at no distant date, be wired and running. This is rather unfair to the alternate-current system, because if we have for some years to come only two out of ten houses, it makes an enormous difference in favour of the transformer system. Again, in speaking of the very high insulation required for the high volts, is it necessary, in the face of the most valuable tables that are given in this Paper, to go so far as 2,000 volts? A great deal has been said about the copper varying inversely as the square of the volts, and so on; but considering the percentage of copper in the tables before you, its value is a ridiculously small amount, and if you take 3,000 volts, as has been suggested by some, instead of 2,000 volts, you get about 22 millimetres instead of 50 millimetres for the area, and you only save 22 per cent. of the total cost. No doubt the proportion of copper in the two cases is as 4 is to 9, but still, according to the figures in the Table No. 1, the cost will be about £11,200, against £14,270, and if you reduce down to 1,500, which is the point suggested by Prof. Elihu Thomson as the limit of high volts, you get 90 millimetres, which would cost £90 per 100 yards, or an increase of 26 per cent., according to Mr. Crompton's figures. I quite agree with Major-General Webber, who has pointed out that the bare copper seems likely to get into difficulties, and I should say much more so than a properly laid cable in a good tube or culvert, and it certainly seems hardly fair to give a higher rate of depreciation for the bar copper than for the insulated cable. Mr. Kapp has spoken of large transformers which are "banked" on a common network, but he did not suggest what should be done when one breaks down and throws a heavier load on the others. No doubt he thought of that before suggesting the method. But supposing that these large transformers are put down at the present day, when only two out of ten houses are taken up, when the time comes for two out of three we can surely afford to get a room in a mews, as suggested by Mr. Crompton, and probably the room over it can be had when the time comes for exchanging them for batteries and an attendant. It is quite possible that the time may come when batteries will be used to the exclusion of transformers, and then the only change will be in the dynamos and the transformers, which are not a very serious part of the whole. The houses will be ready wired, and the mains might be arranged so as to be available for either system. A question has been raised about the difficulty of working with high volts with batteries, and I see no reason why Mr. Crompton should not go further with his high volts, and put down yet more batteries; for nothing could be easier than to run several dynamos in series, for we all know that this is not a difficult matter, certainly not half so difficult as to run alternate-current machines in parallel. There should be no reason why in the future, when we come to something like unanimity on the subject, several stations should not be thrown into a general system; or at all events one district could help another, as is done by the waterworks in the North of England.

The discussion was then adjourned until Thursday, the 26th inst.

* Dr. Fleming informs me that this is the case.—A. P. T.

EDISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

THURSDAY, APRIL 19TH—*continued.*

In his re-examination by Mr. MOULTON, Dr. JOHN HOPKINSON said in Mr. Edison's patents, specifications, and designs, many other modes of making the filament had been proposed, but so far as he knew they all fell within Mr. Edison's claim, or within that which he described. A very large number of people had been using endeavours to get the very best possible filament. The fact that the filaments were made with some of these improvements did not, in his opinion, show that Mr. Edison's method was impracticable.

Take first the difficulty which is suggested of carbonising a small object like this. In your opinion would a person trying honestly to carry out the instructions of this specification take care to eliminate the small quantities of oxygen?—Oh, yes; the most elementary knowledge of chemistry would tell him that.

Do you think, with knowledge of the improvements, it is possible to make a practical lamp with wood splints?—I have not the least doubt about it.

Have you any doubt as to the infringed lamp containing a filament?—Oh, no; that is palpable and distinct.

In your opinion is there anything in the provisional specification of Lane-Fox of 1879 which would be sufficient to enable a competent workman to construct such a lamp as is described in Edison's specification?—Certainly not; it does not even tell you that you are to carbonise the material after it has been formed.

Is there anything to show that it is to be a filament it all?—No; I should rather infer it was to be of considerable section.

Down to the present time have you ever heard of any lamp being made according to the description here?—No.

With regard to the 1879 patent, are there sufficient instructions there to enable a competent workman to make such a lamp as is described in the Edison patent?—Certainly not.

Have you ever down to the present time known a lamp so made?—No; I do not think so.

Mr. JUSTICE KAY: You mean according to Lane-Fox's specification.

Witness: According to Lane-Fox's specification.

Witness also said, with reference to the Carré carbons, that they were made also exclusively for arc lighting. He did not know that they were ever made for incandescent lighting.

With regard to the Cheesborough patent, witness said that a competent workman desiring to carry out that invention would have no difficulty in doing so if he had before him the description of Cheesborough.

Mr. JOHN IMRAY, in reply to Mr. ASTON, said he had given particular attention to the construction and use of incandescent electric lamps since their first introduction, at all events during the last twenty or thirty years. Referred to the specification of Edison's patent, witness said he had made himself familiar with it. He agreed with the evidence of Sir Frederick Bramwell on the point, with the addition that he thought the filaments might be made in all the various ways described, and would work well in all those ways.

Did you give that as a mere matter of opinion, or did you try experiments which justify you in coming to that conclusion?—I have tried five of them.

Witness also said that he was acquainted with the contents of the Cheesborough specification; as regarded the directions for the preparation of the carbon, he thought they were very simple and very clear. On this point he also agreed with Sir Frederick Bramwell and Dr. Hopkinson.

Cross-examined by Sir HORACE DAVEY, Witness said he examined the lamps yesterday, and the reason why he did not submit them to a longer examination was because he had not the time for it. His experiments would give no information as to the durability of the filament.

I observe on the lamp with the cotton thread smeared with lampblack there is a brown sooty deposit on the glass after only trying it for two or three minutes?—It is scarcely sooty; I understand this was worked previously. I think that is most likely some of the vapour of the tar. The attachment to the platinum wires is by means of the compound of lampblack and tar.

I am told that is impossible, because that little cross-piece of glass would have been melted if it had been?—If it had been carbonised after the attachment that piece of glass would have been melted; it could not have been carbonised after the glass was there.

You do not call that a practical lamp, surely; did you ever see such a clumsy lamp as the one called J I 3? Do you call that a filament?—

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Yes, I do. I did not try the resistance of it, but I should think it is a low-resistance lamp.

Another lamp, F J B 1, was then handed to witness, who said it differed from J I 3 in this respect, that what he called a filament was a thing that was flexible before it was carbonised, and he did not think F J B 1 (Swan lamp) was. Asked whether there was anything in Edison's patent showing that it was to be flexible before being carbonised, he said all the modes of making it described in the patent would produce such a filament. That was not the only distinction he could draw between these two lamps. In Swan's lamp, for instance, the rod or stick of tar was of considerable size; in the other lamp the width was relatively considerable, but the thickness was very little. He did not know whether the cardboard one which he produced was of higher resistance than Swan's lamp, and could not form any opinion, because the resistance depended not only upon the sectional area, but also upon the quantity of carbon.

Assuming that the conductor in Swan's lamp received its present form before it was carbonised, can you draw any distinction other than what you mentioned between those lamps?—No; except that I do not think in Swan's lamp this is of the nature of a filament, and flexible.

Do you know that Swan's lamp burnt for an hour?—I have heard so.

Mr. ASTON: 40 minutes?

Having regard to the fact that his claim relates only to the method of making the illuminating portion of the lamp, do you not think that Cheesborough contemplated that the material which he does obtain in the way described would be useful for that purpose?—I do not think so.

At the request of Sir Horace Davey it was then arranged that one gentleman from each side should measure the resistance of lamps J I 1 to J I 5, and the lamps were then handed over to the parties, who left the court for the purpose of examining the lamps.

In re-examination by Mr. ASTON, Witness said that the brownish deposit on the inside of the globe was not usual now that the filaments were very much improved, but it was very usual at first.

Mr. EDWARD GIMINGHAM, in reply to Mr. MOULTON, said he was in the employ of the plaintiff company. Edison's specification had been placed in his hands, and he was told to make certain lamps from it. That was two years ago, and again at the beginning of this year. Mr. Imray had produced certain lamps—J I 1 to J I 5—which had been all made by him (witness). Some of those lamps were made four years ago, before the trial of Woodhouse and Rawson; but, although in court, they were not then produced. Beyond the instructions given in the specification no instructions were given to him in making the lamps, except a special instruction not to pass the current through the filament while it was being exhausted. Witness then described in detail the manufacture of the lamps in question.

His examination had not concluded when the Court adjourned for luncheon.

In cross-examination by Sir HORACE DAVEY, Witness was asked as to the several descriptions of lamps which he had manufactured since entering the employment of the plaintiffs. He stated that he made them from the specification of Edison's patent, and with no other instructions. Questioned as to a lamp with a cotton thread burner, and asked how he carbonised it, he explained that he took some ordinary sewing thread off a reel, and made a little framework of wood with two carbon rods, round which he wound the cotton, in order to get the shape. He then put it in the crucible and dusted in some plumbago, and heated it very hot over one of Fletcher's gas furnaces.

I suppose you previously knew how to make filaments?—I knew how to carbonise, and reading in the specification that you were to carbonise I knew that you must exclude air.

Where are there any instructions in the specification about the exclusion of air?—There are none, but I knew air must be excluded in order to carbonise. It simply says make it into a spiral.

You made a wooden frame?—Yes; to keep the carbon rods apart. I put them into a conical shaped crucible and dusted in lampblack.

Where do you find any directions in Edison's specification as to wooden frames?—There are none; I chose the way which I thought best.

Where are there any directions about plumbago?—I do not see any. I thought that would be best. I closed it as much as possible by filling it up.

What was the object of winding the thread on anything?—To get the shape.

If you had not taken some precaution it would have been crinkled up, would it not?—Yes; I suppose so. Before I made the wooden frame I tried placing it amongst broken bits of plumbago, but the result was that it was distorted. I tried several ways; it took two or three days before I discovered the best way of doing it.

Did you try the putty filament?—Yes; I rolled the putty out into a long, thin filament.

You did not carbonise that at once?—I let the putty dry, and then fastened it on wires, and put it into an oven to drive off all the tar.

Do you suggest that that is in accordance with Edison's directions?—He says carbonise, and I took the best means I could. I expected the tar would go off.

Does not Edison tell you to carbonise the putty wire before it is attached to the platina wires, and then carbonise the whole thing?—It does not direct you there to join it to the platina.

Was it not very brittle?—It was brittle compared with the other. I do not think it would stand handling with the fingers.

What precaution did you take to preserve the shape?—I made a spiral of copper wire, and then placed the flexible lampblack and tar between the coils. I afterwards dissolved the copper, and the spiral was left.

Can you show me a lamp with a filament of that sort?—No.

What heat did you use?—A copper oven heated by a Bunsen underneath. I thought if I got the lampblack and tar into the bulb it would do without having a spiral. I made a roll of paper, and wound the flexible lampblack and tar round it, and afterwards took away the carbonised paper. I put that into a lamp. They would not stand much knocking about, and soon broke in carriage. I should not choose that way of making a lamp, but I am certain that in time I could make one of those to be a practical lamp. All the other lamps are here. They light up very well indeed. I have lamps here that gave an average of 87 hours. They are thread lamps.

When you were exhausting the air from the bulb, did you use any external heat?—Yes; there was a gas burner underneath helping to drive the air out.

Re-examined: I had not been employed either by the Edison Company or the Swan Company before I made these lamps two years ago. I had a previous knowledge of chemistry. I had been to the Science and Art classes, and passed an elementary examination in chemistry at South Kensington; and in making these lamps I did my best with the knowledge I then possessed. Except that knowledge, and Edison's specification, I had no other instruction.

Taking any one of these methods given in the specification, could you have made practical lamps with it?—Certainly.

Dr. JOHN AMBROSE FLEMING, examined by Mr. ASTON, Q.C., said he had devoted considerable attention to the manufacture of electric lamps. He had heard the evidence of Sir Frederick Bramwell, Dr. Hopkinson and Mr. Imray, and he substantially agreed with those witnesses.

You have had practical experience in the testing of lamps?—I have.

Have you tested any of the lamps made by the last witness?—I have tested some of them by measuring. I tested the lampblack and tar filament lamps by passing an electric current through them. I also tested the common cotton thread lamps. I passed a current through the lamp and measured the strength of the electric current and the electromotive force. I found that the current was half an ampere, and the electromotive force 50 volts, and the resistance of the lamp, hot, about 100 ohms when the lamp was brought to its proper incandescence.

Did you test it for duration?—No.

Now take the next lamp, marked E G 2. This is a lamp made with cotton thread rubbed with lampblack and tar. I did not measure the resistance of this particular lamp. I saw several of these lamps burning made from the same batch. I did not myself watch them very long, but we have records of the duration made by the last witness. I directed some lamps to be tested for duration. They were made of cotton thread rubbed with lampblack and tar.

What do you say as to the directions given in the specification?—I think they are sufficient to enable a workman to make these lamps. I heard the evidence of the last witness, and I think he proceeded in the right way.

Cross-examined by Sir HORACE DAVEY: I am at present in the employment of the plaintiff company as electrician, and I am well acquainted with the process of manufacture pursued by them.

There are four processes, are there not—carbonising the filament, the flashing process, attaching the carbon filament, and enclosing in the bulb?—Yes.

Is any single one done in the way described in Edison's patent? In the formation of the filament you do not use any single one of the modes suggested by Mr. Edison, do you?—Yes; we use the process which is indicated on page 3, "cotton thread properly carbonised."

But you have a trade secret about that, have you not; it is not a simple cotton thread?—It is a cotton thread which has been parchmentised.

And is that the trade secret connected with this process?—The mode of carrying that out in a commercial manner is a trade secret. The parchmentisation is not described in Edison's specification.

Now, with regard to the method described as carbonising in a close chamber, have you a trade secret with regard to that?—There is a secret in connection with the process of carbonising on a large scale.

As to heating in hydro-carbon, do you practise Cheesborough with something else?—We practise Cheesborough.

Do you use it only for getting your filaments of uniform resistance?—Yes.

Is there a trade secret as to that?—In the process of commercial manufacture on a large scale, to avoid wasters, there are methods employed which are trade secrets.

How do you attach your platina wires—by electro-plating?—It is not attached by electro-plating.

Is it attached in the mode indicated by Edison in his patent?—No.

And that is a trade secret, too?—It is.

Mr. ASTON: Have you any doubt that an incandescent lamp made with a filament composed of lampblack and tar, as described, would be useful?—A lamp so made might be made a very good commercial lamp, in my opinion.

Now, about these secret processes; you say they apply to operations that are carried on on a large scale?—Yes.

With what object are those processes employed?—The object is to save wasters in the manufacture.

Mr. GIMINGHAM recalled, examined by Mr. MOULTON: In addition to the lamp put in before, did you make others, some of which were run for duration?—Yes. [Lamps produced.]

How were they made?—They were made with thread rubbed with lampblack and tar.

And did you abstain from heating during exhaustion, in the same way as the other?—Yes.

In testing for duration, did you run them till they broke down?—Yes, I ran seven together.

What was the average number of hours they stood?—87·5 hours.

What was the longest and what the shortest duration?—The longest was 190 hours, and the shortest 40 hours.

Mr. ASTON: I should have wished to call Prof. Dewar now, but he is not able to be here.

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His LORDSHIP : We do not want any further scientific evidence.

Mr. ASTON : Then that is the plaintiffs' case. I do not intend to make any comment at this stage. I propose that the judgments in the former case should be brought under your lordship's notice.

Mr. JUSTICE KAY : Those judgments proceeded on other evidence ; therefore, I am bound to make up my own mind on the evidence before me.

Mr. ASTON : I thought those portions of the judgments which refer to the construction of the specification might be useful.

His LORDSHIP : Very well.

The Court then adjourned till Tuesday, April 24.

TUESDAY AND WEDNESDAY, APRIL 24TH AND 25TH.

Sir HORACE DAVEY, opening the case for the defendants, said that he was to some extent in a peculiar position, as an action on the same patents had, as his lordship was aware, been already brought against other defendants by the plaintiff company, and his lordship might perhaps be aware that he appeared on behalf of the defendants. The case against Woodhouse and Rawson went to appeal. Of course, his lordship would form his own decision, but he felt called upon to say that in the first action the defendants relied almost entirely on what was known as Swan's stick lamp as anticipation of Edison's patent, and, depending almost exclusively on the cross-examination of the plaintiffs' witnesses, brought little evidence on their own side. He (Sir Horace Davey) relied on Swan's low-resistance lamp as anticipation, but he by no means relied on that alone. He had evidence which he would bring forward to show that Swan and Stearn not only made, he might say, numerous low-resistance lamps, but that before the date of Edison's application they made lamps with burners of paper or thread, and that these were publicly exhibited. His lordship was well aware that evidence that appeared conclusive in consultation was occasionally liable to fall to pieces under cross-examination in the box, especially evidence of this nature, so he would not at present rely upon it too much, but would wait until his lordship had heard it.

The first case of anticipation that he thought it necessary to call his lordship's attention to was that of King. King used a plate or sheet of carbon made as thin as possible in a Torricellian vacuum. The inventor particularly mentions that the carbon is to be thin, and if it is thin it must have high resistance. The carbon was not in such a perfect vacuum as would now be used ; but the inventor used the best vacuum he could obtain at that date. It must be remembered that the Sprengel pump, which has made incandescent lamp manufacture commercially practicable, was not invented till long after King's time. We have here, then, all the elements of Edison's lamp, the difference being in degree only. The next anticipation is that of an "ingenious gentleman" named Roberts. He used a very thin rod of carbon, supported in a glass bulb by two clamps fastened to leading-in connections. The base of the lamp was not glass, however, but was made of brass, and was connected with a pump by a tube with a stopcock. The most important anticipations were those of Lane-Fox and Swan. He would ask his lordship to turn to Lane-Fox's specification No. 3,988 of 1878. On page 3, line 23, the specification runs :—"The material or alloy employed" (for incandescent conductors) "should be capable of standing as high a degree of temperature as possible without fusing, volatilising, or falling to pieces; it should also have a high specific resistance." Mr. Lane-Fox here points out the very thing on which Mr. Edison lays so much stress in his later specification. "The higher the temperature to which the material can be raised, the more economical will be the light produced—that is, the light will be greater in proportion to the force or energy expended, inasmuch as the radiant energy proceeding from the surface of the material will be more and more luminous as the temperature increases. In order to prevent the deterioration of the material, I sometimes surround it with an atmosphere of nitrogen gas. The quantity of light will be proportional to the extent of the luminous surface. The resistance of the luminous material and its extent of surface should therefore depend on the amount of light it is required to give and the electromotive force used. Speaking broadly, it may be said that the resistance of the luminous conductor should be so adjusted or fixed that the electromotive force of the mains to which it is attached is just sufficient to develop within it the strength of current necessary to raise it to the right degree of incandescence." These passages showed that in 1879 Edison did not discover the laws or principles relating to parallel distribution. Lane-Fox goes on : "In order that the electric force may be conveyed at a higher tension—that is, having high electromotive force, so that there may not be very great loss from the resistance of the conducting mains or conductors—I make the lamps, when I use an alloy of platinum and iridium, of lengths of fine wires, so that I may get a high resistance without having a large extent of luminous surface." Lane-Fox thus clearly explains what is necessary for parallel lighting. If his lordship would kindly turn to Lane-Fox's specification No. 4,043 of 1878, p. 3, he would find the inventor referred to the patent just quoted, and said also :—"I sometimes employ asbestos or other suitable non-conducting refractory material saturated or impregnated with some conducting refractory material, such, for example, as carbon or iridium." In provisional specification 1,122 of 1879 Lane-Fox refers to 140 volts as convenient in the mains, and 300 ohms as a good resistance for the lamp. Mr. Lane-Fox goes on :—"The parts before described are hermetically enclosed within a globe or other form of glass or other suitable material, through one portion of which the conducting wires are hermetically carried. From this globe all trace of oxygen, carbonic acid gas, water, and any gas or vapour capable of attacking or affecting the material of the luminous bridge when at a high temperature must be removed." This last passage has been interpreted to mean that the globe was filled with some inert gas, such as nitrogen, but at any rate it is perfectly consistent with the use of a vacuum.

Mr. Swan's lamp consisted of a conductor of carbon, apparently of low resistance. He understood there was some loose contact now which precluded accurate measurement of the resistance of the conductor. The lamp had had a long litigious life, which had, of course, done it harm. The plaintiffs had held that one of the great advances of Edison, and one of the *differentia* of "filament" was that it was formed before carbonisation. Yet the plaintiffs' witnesses were forced to admit that there were no reasons to suppose Swan's conductor had been made by means of saw and file, and that it might certainly have been made of Carré carbon, as he would prove it really was. The plaintiffs' witnesses were unable to find any evidence of difference between Swan's conductor and Carré carbon, and it was admitted that Carré's carbons were shaped before carbonisation. Sometimes his learned friends held that a filament was a conductor of small cross section. He would ask his lordship to look at the cardboard lamp put in by the plaintiffs as made in accordance with Edison's specification, and claimed by Mr. Imray as an Edison filament lamp. Its resistance was 4·5 ohms, and its surface about the same as Swan's. Swan's resistance was estimated at four ohms. Swan's lamp was, therefore, as much under Edison's claim as the cardboard exhibit, and would therefore invalidate the patent. His lordship would notice that Swan's lamp was to some extent "smoked." This smoking was because Swan did not at that date realise the bad effect of occluded gases in the carbon. He had done so soon afterwards. His lordship would notice, however, that the lamps put in as made according to Edison's specification were also smoked, so that in this respect Edison was just as backward as Swan.

Sir Horace Davey then turned to Edison's own specification, No. 4,576, of 1879. His first objection to this was insufficiency of description. He might, and perhaps would, call many scientific gentlemen who would explain that the instructions were meagre and misleading, but he might also rely on the plaintiffs' evidence alone. In the first place Edison gave no instructions as to how to carbonise. Carbonising such things as charcoal, even for gunpowder, was a known process in 1879, but there was no practice that would guide a workman as to carbonising such things as carbon filaments. This was proved by Sir Frederick Bramwell himself. Even in 1888, here we have Sir Frederick Bramwell, who tells us the workman might use sand. It would have been needless to remind his lordship that sand would most certainly not do. There would be quite enough oxygen in the interstices of the sand to consume a filament entirely, or to injure it and make it inoperative. "Our exceedingly ingenious young friend, Mr. Gimingham," dusted in graphite and bits of broken filament, but he was unable to find any direction to do this in the specification. In answer to an apparently harmless question from Mr. Moulton, the same witness had informed the Court that he wound the cotton thread on a carbon and wood frame, and this he had evolved entirely from his inner consciousness, from his knowledge of carbonisation. This was remarkable, for the wood and carbon frame was an exceedindly ingenious invention, which took some weeks to work out. It was found, after the date of Edison's specification, that the threads contracted so much in the act of carbonisation that they broke. Carbon threads were, of course, obtained, but they were broken and useless for the purpose of incandescent lamps. After many experiments the method of using a frame made of wood and carbon rods was discovered or worked out. The wood carbonises at the same time as the threads, and shrinks with them, so that the threads are not broken during carbonisation, but are kept in shape. Then, on going to the coiled filaments, the witness admitted that it was practically impossible to succeed, though he might have done so if he had had enough time allowed him. That the instructions as to carbonisation are insufficient was admitted, practically, by Edison himself. He had taken out subsequent patents for methods of carbonising. In one case he described elaborate moulds, in which the material or filament to be carbonised was held in such a way that it could contract without spoiling its shape. Now, all this was, according to his view, a tacit admission that his earlier patent, the one now the subject of this action, gave insufficient description. He also took out a patent describing the use of bamboo as a material for the manufacture of filaments. Mr. Edison also shows that his object was not always to make his conductor thin. He wants considerable mass, and wishes to coil the conductor so as to get little radiating surface and large mass. His object was then to make his filament thick. His learned friends were, if he might venture to say so, very slippery. Sometimes a filament was one thing, sometimes another ; but the utmost that had ever been said in the way of definition was that a filament was something of filamentous character. Sometimes a filament must have high resistance, but lamps of a few ohms were included by the plaintiffs as made according to Edison's specification. Sometimes a filament was a thin conductor ; but then they claimed a lamp whose conductor was about as large as that of Swan's stick lamp, and Edison here directs that his conductor may be comparatively thick. Whenever anybody wished to insult Swan's lamp he called it a stick lamp.

Sir Horace Davey asked his lordship to turn to the claims. The first was held by the Court of Appeal to be for a lamp made with the filament as described, and secured as set forth, so that it did not cover other kinds of filaments, or filaments otherwise secured. The second claim covered all filaments. His lordship might, perhaps, be bound to accept the construction of the Court of Appeal as to this claim, unless in this case they brought forward new evidence which would give grounds not existing before for another interpretation. He hoped his lordship might do so.

His LORDSHIP asked whether if Edison had discovered a new principle, and had described one operative method of carrying it into effect, he would be entitled to every other method.

Sir HORACE DAVEY thought he would, provided he had discovered a new principle, but in this case the principle was well known ; so Edison

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must in his specification give instructions whereby each of several methods of working his invention described may be carried into effect. In the case where the inventor did not discover any new principle, one alternative method that is inoperative would invalidate the patent. He (Sir Horace Davey) read many quotations and cited numerous authorities, such as the aniline case. In this case the patentee directed that a compound was to be treated with sulphuric acid or heated, but it was found to be necessary that it should be heated, it would not work cold, and the patent was held invalid on that ground. If there was any one way in particular which Edison preferred, it was the coiled putty of lampblack and tar. It was the only one described at full length and the only one illustrated. It was also remarkable that Edison did not use the term "filament" till he described his lampblack and tar conductor. Yet this form of all was the most impracticable. The plaintiffs had failed completely to make any such lamp according to the specification. He was instructed that the third claim was for an arrangement which was of no practical use, and was old. The fourth was for the method of securing the filament to the leading-in wires, and he would call witnesses to show that it was inoperative.

Before leaving Edison, he would call his lordship's attention to the fact that, though Edison did not hide his light under a bushel, he had never made any lamps under his specification. In the last case his learned friends had referred to the "world-wide Edison lamp"; and what was the "world-wide Edison lamy"? It was a bamboo lamp made with all the modern improvements worked out by Edison and others, and it was all these innumerable improvements in manufacturing details that made the lamp practical. The first Edison lamps were exhibited towards the latter part of 1881. He would not treat Cheesborough at any great length. He would merely call his lordship's attention to the point that the patent was for a material, not for a process of manufacture. The material was precisely the same as that described by Deprez, and the method of making it was the same. The purpose or application was different, but the claim was for the material, and nothing was said in the specification about the application of it. The patent was also void because the directions were misleading. Cheesborough proposed to enclose a carbon conductor in a tube of lime, and heat it electrically in a carbonaceous gas, so that the carbon would be deposited on the lime. He was instructed that at that temperature the carbon would reduce the lime and be attacked, and the calcium would melt or volatilise, and the process would be inoperative. Cheesborough also proposes to saw or cut up his material into sticks, precisely the mode condemned by his learned friends in the case of Swan's low-resistance lamp.

Mr. ROBERT PERCY SELLON, sworn and examined by Mr. FINLAY, said that he was chief electrician to the Anglo-American Brush Electric Lighting Corporation, and had been engaged on electrical matters for the last eight years or more. He was familiar with the process of the Anglo-American Corporation in making lamps.

What is the material which you take for the manufacture of the carbon used to form the burner?—The material is cellulose in an exceedingly pure condition. It is formed by dissolving ordinary cotton wool in a solution of chloride of zinc. By the application of slight heat this produces a viscous semi-liquid mass.

Mr. JUSTICE KAY: The fibres are dissolved?—The cellular or structural character is entirely destroyed.

Mr. FINLAY: What do you then do with that material?—The material is then forced through a die or small orifice, and is allowed to pass into alcohol. The effect of the alcohol is to precipitate the liquid emerging from the die in the form of a thread.

How is it forced through the die which you have mentioned?—By a pressure applied in any convenient way; in fact, it is applied by a head of mercury.

Before forcing it out in that way, do you take any steps to remove the air bubbles in the viscous mass?—Yes; before passing through the die it is boiled.

Mr. JUSTICE KAY: The air is first removed by boiling the viscous mass?—Yes, with an air pump connected with the vessel containing the mass, which is worked while it is boiling—heating and pumping simultaneously.

Mr. FINLAY: Then it comes out into a thread-like form, and passes out into alcohol, as you described just now?—That is so. I should just like to mention this point, that the effect of the alcohol is not only to stiffen the thread, but to withdraw at the same time the metallic salts—that is, the zinc chloride and any other impurities.

I think you complete the stiffening as well as the removal of any impurities by further steeping in another jar of alcohol for a long time?—That is so; it is left to soak in another jar of alcohol. The result is a non-structural thread of cellulose in an exceedingly pure condition. [A specimen was handed to the witness.] This is a specimen after it has been soaked. It is merely allowed to dry in the atmosphere.

Just explain how the drying is effected?—The thread, while still wet, is wound upon wooden drums, which are covered upon the surface with velvet. A considerable amount of contraction takes place during the drying, and there is sufficient "give" in the velvet to prevent the fracture of the material while drying.

What is the next stage in your process?—The next stage is to wind that material upon a block of plumbago, a specimen of which was shown.

Wound on a piece of cardboard?—A piece of cardboard at the bottom. That is to allow for the contraction, and the form is retained by the cotton thread wound round the block.

To allow for the contraction in a subsequent process?—In a subsequent process of carbonisation.

It ends in a process of carbonisation?—That is so.

That is, by the consumption of the carbon?—By the consumption of the carbon.

Of course, the thread as it carbonises contracts somewhat?—Very considerably.

And the cardboard, which is also carbonised, contracts at the same time?—It also contracts. It consumes away at an early stage of the carbonisation, in fact.

Will you describe now how the carbonisation is effected?—One or more blocks in that form [referring to the specimen already produced] having this material wound upon them are packed upon one another in a plumbago crucible filled with powdered plumbago. A little paraffin wax is placed at the bottom of the crucible. This, by melting at an early stage of the carbonisation, drives off any deleterious gases in the interstices of the plumbago.

Mr. JUSTICE KAY: And replaces them with what?—Paraffin wax is a hydro-carbon, and there would be a combination with the vaporised paraffin wax.

Mr. FINLAY: The crucible of course is closed, and placed in the furnace.—Yes.

How do you apply the temperature, and up to what point?—We commence by applying the temperature gradually. It takes some half a dozen hours to raise the temperature up to a white heat. The object of gradually applying the temperature is that the volatile matters in the carbonisable material should not be driven off too rapidly and deteriorate the carbonisable threads. At the end of the six hours of gradual heating the temperature is raised to the most intense point that the furnace will allow of; that is probably about 3,000° F., so far as one can judge, and that is kept up for several hours.

The total period in the furnace is, I think, about eleven hours?—About eleven hours. The crucible is then taken out to cool, and the plumbago blocks with the carbonised thread upon them withdrawn. The carbonised materials are taken off the plumbago moulds. [The witness produced specimens of the carbonised threads as they are taken off the moulds.] The carbonised thread is then mounted in temporary metallic clips, and subjected to the process of electrical heating in a hydro-carbon atmosphere.

How long do you continue to send the current through the thread or filament in this atmosphere?—The current is only passed through for a few seconds, the object of the process being to obtain relative uniformity of resistance between carbon and carbon.

I understand that to mean you keep the current going until the instrument shows a certain amount of resistance in each case?—We do not actually do that. The current is allowed to pass intermittently; and the resistance, as we practise it, is taken between the intermission of the current while the burner is cold. The current is applied from moment to moment.

If you find that it is not right, do you apply the current again?—We apply the current again.

How do you measure the resistance?—It is measured by an ordinary Wheatstone bridge.

And, then, if it is not right, you do what?—We again apply the current, and again measure the resistance, and that is continued until the desired resistance is arrived at. I may mention that the amount of deposit required to produce this uniformity is really very small, amounting in practice to about 5 to 10 per cent. of the total bulk of the burner. The next step is to "mount," as it is called, the burner upon its platinum wires. The burner is inserted in platinum supports, twisted into a small spiral at the ends. These are specimens of the platinum supports ready to have the burner fixed in. [Producing them.]

Mr. FINLAY: You stick the flashed filament into the spiral?—Yes; these are specimens of the flashed filament. [Producing them.]

Mr. JUSTICE KAY: They look a little lighter in colour and more glossy than the others.—That is the only way in which you can detect the difference. They are a steel-blue-grey, or a steel-grey.

Mr. FINLAY: Having inserted each end of the filament into the spiral, what do you do?—There is temporarily sufficient friction between the ends of the burner and the platinum spirals to hold them, while the point of junction between the platinum and the carbon is heated in a hydro-carbon atmosphere.

Heated how?—Heated electrically by passing the current through the point of junction.

Then this is the second time it is heated in a hydro-carbon atmosphere?—Yes.

What is the object?—The current is, by means of a special mechanica device, prevented from passing in the body of the burner, and in this way only heats the points of junction. As a consequence, there is a deposit over the points of junction only.

Prevents it passing through the thread?—Through the thread proper.

Only through the two junctions?—Yes.

What is the effect of that upon the junction?—The effect is to obtain a deposit of carbon over the point of junction, and so produce a sound mechanical and electrical joint between the two.

The Court then adjourned.

THURSDAY, APRIL 26.

Mr. R. P. SELLON was further examined by Mr. FINLAY, Q.C. He said that after the process of mounting the carbon thread, the next step was the sealing of the carbon thread, mounted upon its platinum wires, into the glass globe. The next step was to exhaust the globe.

Mr. JUSTICE KAY: I do not think you need describe it in detail. At the lower end of the globe there is a tube which is connected with an air pump, and thus the globe is exhausted. Is that so?—Yes, with this addition, that it is first done with a current, and then without a current, the globe being heated externally, that being to dry off the moisture from the inner surface of the glass, and to expand the air. That completes the process.

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[At this stage a complete globe of the defendants' was produced, shown to witness, and accepted by him as a specimen marked I H 4.]

Mr. FINLAY: You are familiar with the Edison patent which forms the subject of this action?—Yes; I have carried out a considerable number of trials with reference to the processes described.

With what results?—I think the instructions contained in the patent with reference to the manufacture of carbon filament lamps are quite insufficient to enable the workman to make a practically useful lamp.

Which of them have yon tried?—I have tried the whole of the processes except as regards the winding of the carbon upon the copper helix described at p. 4, lines 42 to 46.

And what is the result of your experiments—you say the directions are not sufficient to enable the workmen to make a useful lamp?—Quite insufficient to do so.

Do you produce any specimens of your attempts to carry out Edison's directions?—I have some specimens with me.

Produce them and explain the different processes to which each relates?—I wish to explain that as regards the suggestions towards carbonising described by Mr. Edison, I do not think that workmen would have known in December, 1879, that it would have been necessary to pack the crucible with some material that would prevent the destruction of the carbon burners. When you are dealing with this very slender carbon in incandescent lamps the most rigid exclusion of air is essential; but this is not necessary in the processes of carbonisation as practised in other manufactures. Packing the crucible for carbonising carbons for incandescent lamps with sand would result in the destruction of the carbons.

I ask you the result of your own experiments in endeavouring to carry out Edison's directions in the specification?—In attempting to make lamps in accordance with Edison's instructions I packed the crucible in which the threads and other materials are placed with plumbago, knowing that in the absence of that there would be total destruction of the materials. I produce some samples of cotton threads smeared with lampblack and tar, of paper, and of wood splints, carbonised under these circumstances, and following Edison's directions. The result, so far as the process of carbonising is concerned, has invariably been this, that all the materials mentioned have come out of the carbonising process extremely fragile and roughened, and it was impossible practically to manipulate hem.

You produce specimens made under different processes?—Yes.

They would, I suppose, fall under two groups—fibrous material, such as wood, paper, cotton and thread as the first group; and, secondly, the group where such materials as lampblack and tar are used?—Yes. There are, no doubt, two distinct groups—one which Edison described as fibrous vegetable substances, the second would be lampblack, tar and putty materials. I have numbered the specimens. Nos. 1 to 6 are specimens of carbonised wood splints. I selected boxwood for that purpose, that being the material that would be likely to succeed where a great many others would inevitably fail. In boxwood there is a comparative absence of resinous tarry matter. Nos. 7 and 10 inclusive are cotton threads. They are not smeared or treated in any way. Nos. 11 and 16 inclusive are of paper. Nos. 17 and 18 are cotton threads smeared with lampblack, tar, or putty material.

Would you describe how you treated these various threads?—I carbonised them at a temperature as nearly as I could attain just below that of melted copper. I infer that that was the temperature intended by Edison, from the fact that he says he winds the cotton thread on a copper helix, and afterwards it is eaten away by means of acids.

What is the temperature at which copper will fuse?—2,200° F. In every case the junction with the platinum wires was made in the manner suggested by Edison by pasting the material round the joint.

In any case were you able to get results of practical utility?—In no case. There are several elements of failure, if I may say so, in the process which he describes. Firstly, there is that of carbonisation. Apart from the question of packing with some material, such as either charcoal or plumbago, it is necessary for the production of carbon of any practical value to place them upon moulds, or under some pressure which enables them to retain their form, and which will at the same time permit of the considerable amount of contraction which these vegetable matters undergo during carbonisation.

Is there anything directing that in Edison's specification?—I can find nothing.

And in 1879 would an ordinary workman have known that?—I do not see how he could possibly have known it, having regard to the fact that the carbonising of these slender materials for the purpose of incandescent lamps was quite unknown. When I say unknown I mean it was not commonly known. There were, indeed, several workers who had been engaged on this same question. Among them I name Mr. Lane-Fox and Mr. Swan and Mr. Carré, but it was not common.

Were there other causes of failure?—There is another cause of failure, also common to all the materials suggested in the process of Edison, and that failure is when the platinum wire which is used undergoes the process of carbonising an alloy of platinum is formed. There is a chemical action set up between the platinum and the carbon in the crucible.

That is in the process of mounting?—Yes.

Mr. JUSTICE KAY: What is that alloy?—I believe it is carbide of platinum.

Mr. FINLAY: I understand the effect of this is that the platinum is rendered very porous and rough in character?

Mr. JUSTICE KAY: Is that at the joint?—Witness: The whole of the platinum in the crucible has been subjected in this experiment to the process of carbonisation. The platinum is in this way rendered very brittle, and it becomes very difficult to seal into the glass globe. But even assuming that you succeed in sealing the platinum into the globe, there is great difficulty. I will not say it is impossible, for I have not had a sufficient number of lamps to be able to say so, but I have seen the platinum put into the glass globe, and from the porous character imparted to the platinum you could not obtain a vacuum. That has been upon our usual mercury pumps, and the process of exhaustion has been carried on for a far longer period than is usual with Edison's lamps.

Mr. FINLAY: What is the result?—We find it is impossible to obtain a vacuum. We tried it sufficiently long to convince ourselves that no kind of vacuum would be formed.

Is that the result of putting into the carbonising chamber the carbon wires with the threads mounted upon them as Edison directs?—That is so.

Those two causes of failure you have mentioned are common to the specimens you have produced—fibrous and non-fibrous?—Yes. With reference to this particular exhibit (showing exhibit), box wood, horse-shoe shaped, there is nothing in the samples beyond that the carbons are extremely fragile and roughened on the surface, and in only a very few cases did I succeed in obtaining a complete lamp, consisting of wood splint fixed upon this platinum after the process of carbonisation was over. In the majority of cases the wood has been broken away; and the same remarks apply to the cotton thread and to paper, and there is that element of failure which would certainly stand in the way of enabling a practically useful lamp to be produced from these materials. Vegetable substances, especially those which have undergone a process of manufacture, such for example as cotton thread and paper, contain a great many impurities of various kinds—silica and so on. Unless some precautions are taken to free the material as far as possible from these impurities, such as the process of parchmentising, there is, no doubt, a chemical action set up in the process of carbonisation between those impurities, the cotton threads themselves, and the other materials with the carbon. This results in there being obtained from the carbonising furnaces something very fragile and porous, or coarse-grained in character. And one may say the inevitable result of this must be that when the current is passed through it, it will heat and exhibit bright spots, and in addition to this it will be virtually impossible to get incandescent lamps made out of such materials without what is called running, *i.e.*, yielding a small illuminating power when placed upon a single source of electricity or generation with a dynamo machine. I feel sure that this difficulty is a very real one, from the fact that I am aware—and I believe I know broadly the processes employed in the manufacture of all the best lamps—that no practicable lamp has been made or placed upon the market in which some such process as that of parchmentising has not been adopted. I would wish to add that the remarks which I have been making apply to two lamps made particularly of cotton thread or paper. I am well aware of what is known as the Edison lamp; a lamp made of bamboo fibre has not, to the best of my knowledge, such a process as parchmentising. I believe the bamboo was used direct. With reference to the lampblack and cotton filament, I think it would be absolutely impossible, by following out this process of smearing with putty before carbonisation, to attain results such as I understand Edison to desire to any practical extent.

Mr. FINLAY: Amongst your specimens I do not observe any filament made of lampblack and tar, as suggested by Mr. Edison at page 4, line 1 and following lines?—I have no specimens here, but I may say I have made a great many experiments with the object of testing the practicability of that process.

Mr. JUSTICE KAY: That is what we call the putty filament?—Yes, the putty filament. I followed out Edison's instructions by previously igniting the lampblack in the closed crucible for several hours, as directed at page 4, line 2.

How could it be ignited for several hours?—Well, that is a wrong expression. I afterwards moistened the lampblack with tar, and kneaded the whole until it became thick putty. I endeavoured to roll out pieces of this material in the form of wire to $\frac{1}{1000}$th of an inch in diameter, but the result of all my trials was that the smallest diameter I could obtain before the material cracked and broke into small fragments was about $\frac{1}{100}$th of an inch. I then endeavoured to form these into a spiral, taking Edison's drawing as a guide. Obviously, for the purpose of Edison's spiral, the diameter of the cords must be small, and the convolutions must be close together. All my attempts to obtain a spiral in this form, however, failed, owing to the fact that when the putty was rolled round the small diameter it cracked all through and broke, *i.e.*, it became covered with small cracks.

Mr. JUSTICE KAY: Do you mean it separated?

Witness: It broke in two before I could obtain a spiral of such a form as Mr. Edison describes and shows. I then formed this material into the horseshoe form in order to surmount the difficulty of the crack which resulted from the winding of the spiral. I joined these, mounted them on platinum wires by means of the putty material, moulded round the junction before using, making the junction itself of putty and carbonising it under conditions as regards diameter described by Edison. The result in every case was this—the horseshoes were obtained in an extremely friable condition, so that in many cases they would break on merely lifting them out of the crucible. But in every case, after succeeding in obtaining them from the crucible, they were so extremely fragile that the amount of rough handling that they would ordinarily have to undergo in the subsequent processes of the manufacture of the lamp would almost inevitably break or fracture the horseshoe.

Mr. FINLAY: In your judgment is it possible to make a practicable filament with lampblack and carbon on Mr. Edison's plan?—No.

You have observed what Mr. Edison says about the importance of the spiral form in his specification?—I know he does attach great importance to it.

Have you tried to make filaments other than the filaments of the putty into the spiral form under Mr. Edison's directions?—I have tried the processes which Edison suggests at page 4, lines 9 to 12, *i.e.*, rolling the thread within the putty, but the result was substantially the same as where the putty alone was made use of. It is perfectly true the carbon

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filament is not so liable to crack, rather less liable than the other ; but nevertheless, the material that was upon the thread did crack in every direction, so that it was quite impossible to obtain any practical result.

I think you have prepared a lamp according to Edison's specification as regards the cotton thread ?—Yes (lamp produced). That is the cotton thread alone not parchmentised. Parchmentisation is obtained by treating with sulphuric acid.

Did you put the thread upon a model in the crucible in this case ?—No, this was not fixed upon any model.

What do you say is the result ?—I wish to explain that the process of mounting has not been carried on according to Edison's instructions. The instructions have only been followed as regards the cotton thread alone in the way I have described, and the result has been a burner of a very porous and rough character, and is absolutely wanting in stability to an extent that would render it useless for practical purposes.

Have you tried camphor and oxide of zinc ?—Yes.

How did that answer ?—The result was, when a current was passed through the lamp, the oxide of zinc and camphor combined with the carbon produced carbonic acid, and the metallic base was reduced and volatilised and the surface of the globe obscured, and the resulting carbon was extremely porous and open grained. Such carbon would very soon dis integrate when put into operation. The process could not be used for practical purposes.

You have been familiar with electric lamps in use for a good number of years ?—Yes.

Since 1879 ?—Since 1880.

Have there been in use any lamps made under this patent of Edison's of November, 1879 ?—Certainly not, so far as I am aware.

You are aware of what was being done by Mr. Swan in the matter of incandescent lamps ?—I am aware from what was published of the matter.

Have you made lamps such as were produced by the Attorney-General as samples of his lamps ?—I have. I have them by me.

Can you tell whether you find they worked and how they worked ?—I have produced such lamps as these experimentally, and have tried their working for a considerable number of hours, varying in different cases. I found they worked perfectly satisfactorily as individual lamps.

Mr. JUSTICE KAY : They would not work alongside ?—I mean to say that such lamps, being lamps of low resistance, would not be suited for purposes of distribution where a large number of lamps are being used at distances from the source of generation.

Mr. FINLAY : You exhibit now lamps made according to the model ?—Yes. I did not have the advantage of the model, but they were made in accordance with what I saw of the model and what was published with reference to Mr. Swan's lamp.

What publication do you refer to ?—The lamp was described by Mr. Swan either at one of his lectures or before the Literary and Philosophical Society of Newcastle.

You have seen Mr. Cheesborough's specification, and you have employed the process of flashing ?—Yes ; I have observed the advantages claimed by Cheesborough for the material produced in the way he describes.

Do you employ the process of flashing for that purpose ?—Not for the purpose described by Mr. Cheesborough—that is to say, the main object of the process of electrical heating.

Mr. FINLAY : You have examined and are prepared to show your carbon filaments as they are before and after the process ?—Yes. I have lens which will enable examination to be made on carbon both before and after flashing.

Does the carbon of your filaments require the process for the purpose mentioned by Mr. Cheesborough ?—Broadly speaking it does not. It is so even or dense throughout its length that we have no difficulty, and have actually made lamps without employing the process of flashing at all ; that is to say, there are no inherent defects in the carbon burners themselves, which require to be corrected by this process.

You said, "broadly speaking." Does that mean there is any qualification, and if so, what ?—What I mean to say is this, that the primary object with which we carry out the process is, and is only, that of obtaining relative uniform resistance between burner and burner. It is quite possible, as a matter of fact, that occasionally one in perhaps a considerable number of burners would be obtained from the carbonising furnace which has received some injury. It might have become damaged in some way or other, so that on the passing of the current through it it would be uneven in its cross-section. In such a case the result of subjecting it to the process of electrical heating in carbon gas would be to cure that defect. That is the qualification, but it is quite an exceptional thing.

Would you show a filament under the lens to his lordship ?

Mr. JUSTICE KAY : Better show it to experts.

Mr. FINLAY : You observe the reference to 7,000° F. in Mr. Cheesborough's specification ?—Yes.

What would be the effect of such temperature ?—Obviously the immediate destruction of the carbon subjected to it ; and for this reason, that carbon volatilises in an electrical arc, and the temperature of an electrical arc has been calculated to be about 5,000 or 6,000° F., so that obviously if subjected to a temperature more than 1,000 degrees higher than that it would be instantly destroyed.

What was the resistance of these lamps made by you after the species of Swan's stick lamps ?—Using a carbon of the same length and the same diameter, as nearly as possible to do so, the resistance was I think, between 1 and 2 ohms while cold.

Have you tried the resistance produced as being made by the plaintiffs under Edison's patent ?—I have.

What was their resistance ?—I am sorry to say I have not kept accurate measurement, but I remember clearly that their resistance cold averaged 2½ ohms as nearly as possible.

Mr. Aston, Q.C., asked that as a great deal of the evidence given referred to experiments, he might be allowed to reserve the cross-examination of this witness, but Mr. Justice Kay said he had better go on.

Cross-examined by Mr. ASTON : I understand you to say that you are not familiar with the manufacture of pieces of carbon to be used for electric lighting carbonised in close retorts by means of charcoal ?—I do not mean to imply that I am not familiar with the carbonisation of carbon under conditions where charcoal was used.

I am speaking of 1879.—I was not aware then.

Have you the specifications referred to as the alleged anticipations of Cheesborough's patent ?—I have.

Do you not remember that Stait says that electrodes are improved by being gradually exposed to the strongest white heat of the furnace, enclosed in vessels of charcoal ?—I think he says so.

The learned counsel then read Stait's specification and other specifications, and cross-examined witness with reference to them.

Mr. JUSTICE KAY asked if he was to assume that the contention was that an ordinary workman knew all that was in the book ?

Mr. ASTON said not an ordinary workman, but persons who had to deal with the manufacture of this light brought into use. That, however, would be a matter for argument by-and-bye.

(To be continued.)

MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-NIGHT) FRIDAY, April 27th.

ROYAL INSTITUTION.

9 p.m. "Electrical Influence Machines." By Mr. JAMES WIMSHURST, M.R.I.

SATURDAY, April 28th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Later Works of Richard Wagner" (3). By Mr. C. ARMBRUSTER.

PHYSICAL SOCIETY OF GLASGOW UNIVERSITY.

Paper on "Theory of Gases." By Mr. W. COLQUHOUN, M.A.

PHYSICAL SOCIETY (LONDON).

3 p.m. "On Electromotive Force by Contact." By Mr. C. V. BURTON. "A Theory Concerning the Sudden Loss of Magnetic Properties of Iron and Nickel." By Mr. H. TOMLINSON. Note on "The Graphic Treatment of the Lamont-Frölich Formula for Induced Magnetism;" Note on "The Conditions of Self-Excitement in a Dynamo Machine;" and Note on "The Conditions of Self-Regulation in a Constant Potential Dynamo Machine." By Prof. S. P. THOMPSON.

MONDAY, April 30th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture VI. "The Decoration and Illustration of Books" (1). By Mr. W. CRANE.

TUESDAY, May 1st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed, "The Distribution of Hydraulic Power in London." By Mr. E. B. ELLINGTON, M.I.C.E.

ROYAL INSTITUTION.

1:30 p.m. Annual Meeting.

3 p.m. "The Plant in the War of Nature." By Mr. W. GARDINER.

WEDNESDAY, May 2nd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Drawing, a means of Education." By Mr. T. R. ABLETT. Sir GEORGE BIRDWOOD, M.D., K.C.I.E., C.S.I., in the chair.

THURSDAY, May 3rd.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Chemical Arts" (4). By Prof. DEWAR.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting.

SOCIETY OF MECHANICAL ENGINEERS.

7:30 p.m. Meeting at the Institution of Civil Engineers.

FRIDAY, May 4th.

7:30 p.m. Continuation of last-mentioned meeting.

ROYAL INSTITUTION.

9 p.m. "The Invincible Armada." By Prof. J. K. LAUGHTON.

SOCIETY OF ARTS.

8 p.m. Indian Section. "The Injurious Effects of Canal Irrigation on the Health of the Population of the Punjab." By Surgeon-General H. W. BELLEW, C.S.I., C.I.E. Sir JOSEPH FAYRER K.C.S.I., will preside.

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SPECIAL NOTICE.

With this week's issue we present our readers (Gratis) with a Steel Plate Portrait of SIR JOHN PENDER, K.C.M.G.

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THE SIR JOHN PENDER BANQUET.

Less than a year ago a numerous and distinguished assembly met together in the manner customary among Englishmen to celebrate round the festive board the Jubilee of the Electric Telegraph, and to do honour to the memory of its discoverers who had passed away before that era of its existence was reached. Last Monday evening an equally numerous, and, if possible, still more distinguished, gathering joined in a similar demonstration to commemorate the greatest of all the achievements to which that discovery has been applied, and to do honour to one who has been and is still conspicuously associated with its triumphs. Submarine Telegraphy—or more correctly in this relation sub-oceanic telegraphy—is of comparatively recent date, and the successful laying of the cables uniting this country with America marked a totally new departure with an entirely new field of operations for the art which COOKE and WHEATSTONE had given us nearly thirty years earlier. The completion of that difficult and hazardous enterprise, which at one time threatened to sink past recovery millions of English capital at the bottom of the Atlantic, was largely due to the courage, the energy, and the liberality of the honoured guest at last Mondey's banquet. The possibility of oceanic telegraphy on so vast a scale being once established, its extension in other directions had not long to wait. The far East was soon reached; and in due time the Australasian and South African Colonies, as well as our Indian Empire, with all the intermediate links between us and that splendid dependency, were welded together by a chain of inter-communication as effectual and almost as secure as that which had crossed the silver streak which separates England from France.

To all these far-reaching and momentous enterprises, Mr., now Sir JOHN, PENDER, has lent his powerful aid; and it is hardly an exaggeration to say that wherever submarine tele-

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graphy is known his name will be found associated with it. Mr. JOHN PENDER had earned this world-wide celebrity long before it was publicly recognised in his own country. Honours which are lavishly bestowed for political services are sparingly given to the pioneers of national commerce. Jus recently, however, the QUEEN'S advisers bethought them ot the debt which they owed to this eminent and indefatigable agent in the prosperity of the empire, and HER MAJESTY has been pleased to confer upon him the Order of K.C.M.G. It was to congratulate him upon this well-deserved, though somewhat tardy, recognition of his services that the banquet at the Hôtel Métropole was given; and the proceedings were in every way worthy of the event they intended to celebrate. Perhaps in no other country could such a scene have been witnessed; certainly in no other country is the true value of distinction such as this so frankly acknowledged where at the same time it is as discriminately bestowed. Except for those political services which Lord WOLSELEY evidently holds in very light estimation, and which are peculiar to the parliamentary institutions of this country, honours must be earned before they are had; and every one of the illustrious speakers of the evening gave their ungrudging testimony to the deserts of the man whom the nation has raised to a dignity which, although, as some think, inadequate, is at all events well deserved, and free from what Lord WOLSELEY calls the taint of party politics. The company present on this occasion might have been roughly described as composed of two classes, one of distinguished men who welcomed a fellow worker to their own ranks, the other of men who cheerfully rejoiced in a comrade's promotion from theirs.

Among the former, Lord DERBY, who occupied the chair, paid a very warm tribute of respect and gratitude to Sir JOHN —a tribute all the more valuable as coming from an ex-Colonial Secretary, who, if anybody, should know what submarine telegraphy has done for the Colonies and for England, and none the less genuine for being couched in terms of personal friendship for the recipient. "I ask you," his lordship said, "to join with me in paying this mark of respect to a gentleman whom many of us have known long as a private friend—few, I think, longer than I have—and whom all of us know in his public capacity; to one who has been prosperous enough, I have no doubt, to excite something of that jealousy with which marked success is apt to be attended, but who has attracted in this room a body of friends, which, whether we look to mere numbers, to social importance, to intellectual power, or to the warmth of their attachment, forms such a gathering as has seldom come together in honour of any private individual." Success, as the Chairman afterwards remarked, is not always a sure test of merit, nor failure of demerit; but in this case it was felt both by speaker and audience that the successes were not more remarkable than the qualities by which they had been achieved. These qualities are represented in the best traditions of British commerce and enterprise. It is to the exercise of these qualities that Sir JOHN PENDER owes his prosperous career, and we the prosperity of oceanic telegraphy There need be no illusions on this point. Whatever the State may think fit to do with its inland telegraphs, or with those connecting it to its immediate neighbours, the cable business of the world will probably remain in private hands. At all events, it has never yet been undertaken by the State; and never by anyone, unless for those sound commercial reasons which have impelled men like Sir JOHN PENDER to embark their energy and their capital in ventures which yield a profitable return. These are not the men of "fixed ideas" of whom CARLYLE bids us beware. Their aims are tangible realities; and what they have accomplished is equally removed from the fanciful and ideal.

A passing reference to this aspect of submarine telegraphy was made by Sir JOHN PENDER himself in his response to the toast of the evening. Although, said he, we have laid enough cable to girdle the world many times round, we have not put a girdle round it yet, simply because in our judgment the girdle would not pay. The fancy of a SHAKESPEARE may picture it there, and the "fixed idea" of the member for Canterbury may persist in fixing it there, but for the present cable enterprise must continue to be, as in the past it has been, conducted on sober and matter-of-fact business principles. Incidentally, no doubt, the existence, and possibly the extension, of submarine telegraphy will lend itself to a more sentimental purpose—to solve the great emigration question, for example. It was said by Sir JOHN that the fact of a colony being within speaking distance of the mother country may help to reconcile the surplus populations to the expatriation which in these days they seem so loth to incur, and no doubt this is the case. It will also assist more than anything else can do to bring about, if it has not already created, a practical Imperial Federation, which is the "fixed idea" of so many eminent enthusiasts. Of one thing we need entertain no doubt whatever, although Lord DERBY is not quite sure about it. Whether we, the people of the world, will love one another the better for being so intimately associated is to him an open question. But if the invention of printing made us more sympathetic, more humane, as one of the shrewdest of English novelists once assured us that it did, we may confidently predict a similar effect from the even wider sympathies which the world's telegraphs open up to us. On the whole, and in the long-run, as MATTHEW ARNOLD used to say, the telegraph "makes for" peace by promptly removing the causes of discord. To quote again from CARLYLE, "all quarrels are at bottom the result of misunderstandings;" and nothing contributes to the clearing up of misunderstandings between distant disputants so quickly as the telegraph. If Sir JOHN PENDER had no other title to fame than that of doing so much as he has done to put the world on this friendly footing, the honour lately conferred upon him would have been abundantly earned.

ELECTRIC TRACTION ON THE UNDERGROUND RAILWAY.

A few days since the *Financial News* informed its readers that the Metropolitan District Railway Company was "negotiating an arrangement for the working of its engines by electricity." This important statement will not, however, be new to the electrical world, since we first hinted at the existence of such a scheme more than six months ago, and in our issue of 20th January were able to give further details. It needs no argument to convince a Londoner that the successful adoption of electric traction upon the Underground Railways would immediately be followed by a large increase in the traffic receipts, and any scheme which will alleviate the miseries of the long-suffering millions who daily traverse those dark and dismal regions must command the attention of a very large section of the community. If, in addition, it can be demonstrated that the cost of working the line will be materially diminished, then there would appear to be nothing lacking on the part either of the public or of the railway directors to hasten the inauguration of this much-needed reform.

On the other hand, everyone must recognise that the commencement of anything in the nature of an experiment under the actual working conditions of the Metropolitan Railway is

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a matter requiring the most attentive consideration and the utmost possible care and skill in the arrangements. It is not our wish, therefore, to urge anything like undue haste in the matter, nor is it our intention at the present moment to enter upon a technical discussion of the various possible solutions of the problem which present themselves to the electrical engineer. We wish, however, to submit in very few words some considerations which may tend towards a more rapid and more successful solution than our knowledge of the actual position of affairs leads us at present to anticipate.

It will be within the recollection of our readers that the proposal, which is still under consideration, involves the employment of secondary batteries, and it is quite possible that the promoters of the scheme have not as yet fully satisfied themselves as to the best form of cell for the purpose in view. However this may be, it is easy to understand some of the reasons which have led to the selection of the battery system as the most readily available for a preliminary experiment. The leading idea probably is that the self-contained electric engine, when its development had been perfected, would be able to run in turn with the ordinary traffic without requiring the least modification in the present arrangements. On the other hand, there are very few electrical engineers who would refuse to admit that, if once the experimental difficulties could be overcome, the adoption of a method of working by direct transmission from dynamos is peculiarly well suited to a railway line of this description. That the economy of this scheme would necessarily be higher than that obtainable by means of batteries scarcely requires demonstration. Apart altogether from the question of efficiency and duration of the cells, we must recollect that the batteries have to drag their own weight as well as that of the train; what this implies, where sufficient power has to be provided for starting the train every few minutes, only electrical engineers are in a position fully to appreciate. Our remarks on this point, however, must not be taken as antagonistic to the employment of secondary batteries where their efficiency and economy are beyond dispute.

Now, it seems to us that the difficulty of making a practical experiment with any one of the numerous overhead or conduit systems (which have proved so successful in the United States) may quite easily be overcome. We may add, parenthetically, that the Company which has the matter in hand is undoubtedly as well able to carry out a scheme of this character as the one already proposed. The suggestion which we would venture to make is, in brief, the following:—Let a certain section of the line be provided with conductors, either suspended from the roof of the tunnel or laid between the rails, as may be deemed most convenient. Let a certain number of the trains be provided with an electric locomotive *in addition* to the steam engine. It is obvious that the train could then take its place upon the circle with the rest of the traffic, without the least danger of causing an interruption, the steam engine taking it over the ordinary part of the line, and the electric locomotive doing duty on the electrical section. Over the electrical section the steam engine would, of course, form part of the load to be drawn; but that would enhance the value of the test. Such an experiment as this might be inaugurated at a minimum cost, and could be gradually extended over the whole system as experience and confidence were gained. While frankly confessing the experimental character of these praliminary trials, we are thoroughly persuaded they would result in the removal of any difficulties which at present seem to stand in the way of their success. In the interests alike of the shareholders and passengers of the Metropolitan and District Railways, as well as in those of Electric Traction in general, we trust that the experiment will speedily be made.

BANQUET TO SIR JOHN PENDER, K.C.M.G.

In recognition of the prominent part which has from the outset been taken by Sir John Pender in submarine telegraphy a banquet was given in his honour last Monday evening at the Hôtel Métropole by his friends, principally gentlemen who have been associated with him in the progress of this important enterprise. An extremely interesting feature of the evening's proceedings was the presentation to Lady Pender of a portrait of her husband, Sir John acting as intermediary for her ladyship. The portrait has been painted by Professor Herkomer, and was generally admired.

A large and distinguished company assembled to do honour to the occasion. The Right Hon. the Earl of Derby, K.G., presided, the guests including His Excellency Count van Bylandt, His Excellency Count Piper, the Earl of Jersey, Earl De la Warr, Lord Esher (the Master of the Rolls), General the Right Hon. Viscount Wolseley, G.C.B., G.C.M.G.; Lord Stratheden and Campbell, the Right Hon. Viscount Bury, K.C.M.G.; Lord Chelmsford, G.C.B.; Lord E. G. Fitzmaurice, Viscount Lymington, M.P.; Lord C. J. Hamilton, M.P.; the Right Hon. Sir Henry James, Q.C., M.P.; the Right Hon. C. H. Raikes (Postmaster-General), Sir Lyon Playfair, M.P., K.C.B.; Prof. Ayrton, Dr. Priestley, Mr. Robert Browning, Sir George Elliot, Bart., M.P.; Sir John Hawkshaw, F.R.S.; Sir Stevenson A. Blackwood, K.C.B.; the Right Hon. Sir H. Selwin-Ibbetson, M.P.; and Count Oscar Von Reichenbach. The other gentlemen present, including those forming the committee who promoted and carried out the arrangements of the banquet, were:—Sir James Anderson, W. Andrews, Esq.; Arthur Anderson, Esq.; Kenneth Anderson, Esq.; W. T. Ansell, Esq.; Ben. Ashton, Esq.; Dr. Aikin, the Hon. Wm. St. John Brodrick, M.P.; F. A. Bevan, Esq.; A. H. Berthoud, Esq.; F. W. Bond, Esq.; J. Spencer Balfour, Esq.; the Very Rev. Geo. G. Bradley, Dean of Westminster, D.D.; F. E. Baines, Esq., C.B.; T. Brown, Esq.; W. H. Burman, Esq.; Chas. Burt, Esq.; Sir Arthur Blyth, K.C.M.G., C.B.; G. C. Bompas, Esq.; Sir Graham Berry, K.C.M.G.; J. Bass, Esq.; F. A. Beer, Esq.; Sir F. Dillon Bell, K.C.M.G., C.B.; Major-General Beadle, R.E.; T. G. Bowles, Esq.; Right Hon. Hugh C. E. Childers; Lord Sackville A. Cecil; G. W. Campbell, Esq.; R. M. Cunningham, Esq.; Richard Collett, Esq.; Sir A. L. Cappel, K.C.I.E.; Sir Daniel Cooper, Bart.; Sir Philip Henry W. Currie, K.C.B.; Latimer Clark, Esq.; H. Clifford Esq.; Alexander Crum, Esq.; the Hon. Ralph Dutton; Sir Juland Danvers, K.C.S.I.; Sir H. Des Vœux, Bart.; Edward J. S. Dicey, Esq., C.B.; George Draper, Esq.; E. Dickens, Esq.; R. Dudley, Esq.; E. Duncanson, Esq.; Capt. Davies, Herbert de Reuter, Esq.; C. W. Earle, Esq.; H. G. Erichsen, Esq.; Sir Henry Edwards, the Baron Erlanger, T. Fuller, Esq.; William Ford, Esq.: J. Staats Forbes, Esq.; L. Floersheim, Esq.; H. C. Fischer, Esq.; T. Finnis, Esq.; Henry C. Forde, Esq.; W. Flux, Esq.; C. J. Günther, Esq.; Matthew Gray, Esq.; Sir Gabriel Goldney, Bart.; Thos. Gray, Esq., C.B.; E. Graves, Esq.; Colonel Gouraud, Ch. Gerhardi, Esq,; Sir James F. Garrick, K.C.M.G., Q.C.; H. R. Grenfell, Esq.; J. G. Griffiths, Esq.; Earl of Galloway, K.T.; Admiral Sir Leopold Heath, K.C.B.; Admiral Sir J. C. D. Hay, Bart.; H. Holmes, Esq.; W. G. Hall, Esq.; F. E. Hesse, Esq.; A. R. Hardie, Esq.; J. C. Harker, Esq.; Sir Robert Herbert, K.C.B.; Admiral Sir Anthony H. Hoskins, K.C.B.; Captain Halpin, J. T. Horley, Esq; Keeley Halswelle, Esq.; F. Higgins, Esq.; Ludwig N. Hardy, Esq.; Sir J. Pope Hennessey, K.C.M.G.; W. Hibberdine, Esq.; F. A. Inderwick, Q.C.; Gen. Johnston, C.B.; F. J. Johnston, Esq.; W. Claude Johnson, Esq.; Admiral of the Fleet Sir H. Keppel; C. M. Kennedy, Esq., C.B.; L. Loëffler, Esq.; H. W. Lucy, Esq.; E. L. Lawson, Esq.; C. W. Lundy, Esq.; J. Laister, Esq.; John Latey, jun., Esq.; Admiral R. C. Mayne, M.P.; A. Marshall, Esq.; Peter M'Lagan, M.P.; Sir Halliday Macartney, K.C.M.G.; J. H. Macdonald, Esq. (the Lord Advocate); James McDougall, Esq.; Sir Chas. Mills, K.C.M.G., C.B.; J. Muirhead, Esq.; Dr. A. Muirhead, Wm. Mollison, Esq.; Sir Henry

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Mance, Sir Graham Graham-Montgomery, Bart.; J. F. Moulton, Esq., Q.C.; J. Mackrell, Esq.; G. G. Nicol, Esq.; F. C. C. Nielsen, Esq.; G. R. Neilson, Esq.; Ernest Noel, Esq.; A. Naughty, Esq. (Dingwall); Earl of Onslow, K.C.M.G.; Capt. M. F. Ommanney, R.E., C.M.G.; James Pender, Esq.; John Denison Pender, Esq.; Lord Alfred Paget, C.B.; Captain Pavy, the Hon. Ashley Ponsonby, W. G. Probyn, Esq.; R. Penketh, Esq.; C. H. B. Patey, Esq., C.B.; J. C. Parkinson, Esq.; S. E. Phillips, Esq.; Sir Julian Pauncefote, C.B., G.C.M.G.; W. H. Preece, Esq.; Bennett Pell, Esq.; Prof. Perry, George Pearson, Esq.; R. Lloyd Price, Esq.; Edward Ponsonby, Esq.; W. Payton, Esq.; Admiral Sir G. H. Richards, K.C.B.; H. Roberts, Esq.; A. W. Rixon, Esq.; Dr. W. H. Russell, D. A. MacBean Ross, Esq.; C. W. Stronge, Esq., C.B.; S. W. Silver, Esq.; A. Siemens, Esq.; W. Shuter, Esq.; Leopold Salomons, Esq.; Hon. G. Sackville, James Stern, Esq.; H. A. C. Saunders, Esq.; Thomas Sutherland, Esq., M.P.; Sir T. H. Sanderson, K.C.M.G.; Louis Schott, Esq.; Captain Eyre M. Shaw, C.B.; W. O. Smith, P. B. Smollett, Esq.; W. H. Snell, Esq.; General Tremenheere, G.B., R.E.; Lord Thurlow, J. A. Tobin, Esq.; Charles C. Trevor, Esq., C.B.; H. A. Taylor, Esq.; the Most Hon. the Marquis of Tweeddale, W. J. Tyler, Esq.; Henwood Thomas, Esq.; Captain Trott, E. M. Underdown, Esq., Q.C.; Sir Hussey Vivian, Bart., M.P.; the Hon. Francis H. Villiers, Sir Thomas Villiers-Lister, K.C.M.G.; H. Weaver, Esq.; Major Wood, T. H. Wells, Esq.; Lewis Wells, Esq.; G. H. Wood, Esq.; Edward Wingfield, Esq.; Sir Thos. F. Wade, K.C.B.; Sir Charles Rivers Wilson, K.C.M.G., C.B.; Phillip H. Waterlow, Esq.; T. R. Wilkinson, Esq.; G. G. Ward, Esq. (U.S.A.); W. Wood, Esq.; Arthur Wood, Esq.; Archbishop of York; F. Youle, Esq.; and James F. Youl, Esq.

The "Health of Her Majesty the Queen, the Prince and Princess of Wales, and the other members of the Royal Family" having been drunk with the customary enthusiasm,

LORD DERBY proposed "The Army, the Navy, and Volunteer Forces," coupling with the toast the names of General Lord Wolseley, Admiral Sir Leopold Heath, and Viscount Bury.

The toast having been duly honoured,

LORD WOLSELEY said: Lord Derby, my Lords, and Gentlemen—I have very great pleasure in speaking on behalf of the Army, and in returning you thanks for the cordiality with which this toast has been received; and I am very much obliged to you, Lord Derby, for the very kind manner in which you have personally referred to me. I am very glad to have this opportunity afforded me of speaking on behalf of the profession to which I have the honour of belonging, and to convey an expression on their behalf of gratitude to the guest of this evening, Sir John Pender, for the great kindness we have always received from him and from the companies over which he has so ably presided for so many years. During all the recent little wars we have had in various parts of the world, wherever it has been my good fortune to come in contact with Sir John Pender he has invariably aided and assisted us, not only publicly, but privately, and has done everything he possibly could do in the interest of the public service, and has invariably on all occasions told me whenever I have been drawn into contact with him that he would use every effort to assist private individuals—that is, the sick and wounded—by freely placing the telegraphs with which he was connected at their disposal (cheers). It is no easy matter for an officer holding a public position, as I do, in the War Office, to speak in an open manner about the Army. Of course it is possible to speak on various subjects connected with the discipline of the Army and its organisation and its reorganisation, which has gone on for so many years; but it is no easy matter to speak as I would wish to speak, "from the housetops," about the Army, and not overstep the bounds which a public officer should do. As regards the ordinary affairs of the Army, I think I am justified in saying that in no previous period of our history has it been, as far as it goes, in a more efficient condition (cheers). I believe that officers are far better instructed, far more able to undertake the duties they are called upon to perform, and far more efficient to discharge those duties than I have ever known them (cheers). Now I will mention to you one fact which has lately come to my notice, which speaks volumes for the discipline of our men—that during the last twelve months half of our military prisons have been shut up because we had no one to send into them (cheers). Under our peculiar system of Government it is very difficult indeed, as I have said, for an officer to speak regarding the organisation of the Army, but it is no easy matter to have really an efficient Army at all. It is very curious that though John Bull goes to considerable expense in paying those whom he considers experts to advise him and the country both on the Army and the Navy—admirals and generals who advise him on naval and military matters—that the opinions of those experts, which are so highly praised, are never published, and John Bull, who pays for them, is never made acquainted with what those opinions are. We have from time to time long statements made as to the Army and Navy from gentlemen in power. I have often to listen to them myself, and I often wonder how much those speeches are affected by the Party exigencies of the moment, and how much they represent the opinions of the First Lord of the Admiralty and of the Secretary of State for War. I confess myself that this is a system of which I cannot approve, and I do not believe that any Admiral or General in office, or who has been in office, approves of it, because one and all of us believe that it is a system which sooner or later will land this country in disaster. We live in times when, I think, it behoves the people of England to know not only the truth, but the whole truth, with respect to its Army and Navy (cheers). We see around us all the nations of Europe—certainly all the great nations of Europe—with the one exception of England, armed to the teeth; and as you look around on the political horizon of Europe you can gather no good from it, but it all forebodes storms, and certainly forebodes no good for this country. Those who, like myself, have to study matters connected with the defences of this Empire, not only at home but abroad, have to put this question to ourselves—Are the Army and the Navy as strong as they ought to be? I think very few who have studied this question would admit that they are as strong as they ought to be. But when we come to think why they are not so strong as they should be, surely, as Lord Derby has said, the people of this country have never refused the Ministry any money they have asked for, either for the Army or the Navy; and surely the taxpayers of this country never grudge any money which they are asked to pay for the efficiency of those services. The answer to the question, why the Army and the Navy are not as strong as they ought to be, is to be found in the system of our Government in Party politics—that curse of modern England which is now sapping and undermining the foundations of our country, and which is depriving our statesmen of the manly honesty which was once their characteristic. What do we see when any new Administration comes into office? What directly takes place? It is the same with all Parties. The first thing is the endeavour made by the Minister in office to obtain some clap-trap reputation by cutting down the expenses of the Army and Navy, and when some Minister is enabled to produce an Army and Navy Budget which in some degree represents a smaller sum than that of his predecessor he plumes himself upon the victory he has gained. He is proud that he has succeeded better than, perhaps, his opponent who sits on the bench opposite him, and as he chuckles over this success he says, "See what a good boy am I!" (laughter and cheers). This is the result of—what? The result of a low and vicious standard of morality, which is now uppermost in men's minds. In speaking so light-heartedly of such a matter he forgets, in his pride of having reduced the Estimates, the fault he has committed, the crime he is guilty of against the country (cheers). I hope you will pardon me for speaking so openly as I have done, but I feel deeply on the subject. I feel that we have arrived at an epoch in our history when it behoves public men to speak the truth, and not only the truth, but the whole truth (cheers).

ADMIRAL SIR L. HEATH, in replying for the Navy, said that his profession were very proud at having been associated with the very early days of ocean telegraphy, and they were grateful to those who, with such energy, perseverance and scientific skill, had covered the ocean with their lines.

VISCOUNT BURY replied for the Auxiliary Forces.

LORD DERBY: Sir John Pender, it now devolves upon me to perform a very agreeable duty, and that is to ask you to act as an intermediary for Lady Pender, and on her part to accept from the committee and from your friends who have met in this room the picture which we now see on the opposite wall (cheers). Of that work of art I will only say that it seems to me that the executioner has done full justice to the merits of the subject. I shall immediately proceed on another and not less agreeable task, and that is to propose to you, my lords and gentlemen, the toast of the evening and to ask you to drink the health of our honoured guest and friend, Sir John Pender (cheers). I shall say what I have to say in a few words, and that for several reasons. A tolerable acquaintance with public dinners has taught me that while many speeches are complained of as being too long, none in my recollection was ever complained of as being too short (laughter). That is one reason. Another is that to speak of a distinguished man in terms which one would like to use is easier in his absence than before his face; and this I know, that if my part should be imperfectly played, your sympathy and goodwill, acquired beforehand, will more than supply its deficiency. I ask you to join with me in paying this mark of respect to a gentleman whom many of us have known long as a private friend—few I think longer than I have—and whom all of us know in his public capacity, who has been prosperous enough, I have no doubt, to excite something of that jealousy with which marked success is apt to be attended, but who has brought together in this room a body of friends, which, whether we look to mere numbers, to social importance, to intellectual power, or to the warmth of their attachment, forms such a gathering as has seldom come together in honour of any private individual (cheers). Our friend, as we know, has been the author of his own fortunes, but I am not asking you to pay him honour for being what is called a self-made man. There are many kinds of self-made men, and the value of the article so produced varies greatly. We have heard of some who by the fact of having made themselves have been said to have relieved Providence of a heavy responsibility (laughter). Success is not a sure test of merit, nor failure of demerit; but when we find large means obtained by the industry, the energy, the adventure, and the foresight of a lifetime—when we find a man who has so thriven giving the best of his time and his care to the service of the public; when we know that he employs in liberal hospitality, in the patronage of science and art and the encouragement of industrial enterprise, the fortune which he has acquired, we cannot refuse to pay respect, not to the success which has been achieved, but to the qualities by which it has been earned; not to the wealth which has been accumulated, but to the wise and generous use which has made that accumulation a public benefit and not a public injury (cheers). But, gentlemen, it is not of our friend as a man of business, it is not even of him in his capacity as a former member of Parliament, that I am here to speak to-night. I sat long enough with him in the House of Commons, though not then in the same political connection, to be able

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to bear witness to the respect which was always felt there for his opinion when he chose to give it, and it is something to say of a member of Parliament that he never, so far as I know, made an unnecessary speech or made a speech which did not tell the House something worth knowing (applause). But it is not on the ground of public service that Sir John Pender's name will be entitled to the gratitude and respect of future times. His main work as regards the public is in that field which for many years he made, I will not say exclusively, but principally, his own—I refer, as, of course, you know, to the service which he has rendered to submarine telegraphy (cheers). Of that great branch of enterprise it is not too much to say that he has been the principal promoter (cheers). He was chairman of the British and Irish Magnetic Company at a time when the public idea of carrying wires under a vast stretch of ocean was altogether new and strange. He was one of the largest contributors to the first Atlantic cable projected. He came to the rescue at the moment of greatest difficulty, when the first Atlantic cable parted in mid-ocean, and the company which sent it out could do nothing more. It would have been useless at that moment to appeal to the public. They had been in general mistrustful from the first, and they were utterly disgusted by the failure. It is not too much to affirm that, but for Sir John Pender and for a few others of whom he was the chief, that enterprise would have collapsed, and at best a long delay would have occurred before investors consented to risk their capital in such a speculation again. Of course the thing would have been done at last (Sir John Pender: Hear, hear,) just as some one, no doubt, would have discovered America if Columbus had failed (laughter), and just as the steam engine was bound to come into existence if James Watt had never been born. Great discoveries, great inventions, important applications of science to new purposes, cannot be long delayed or long thwarted by the action of an individual, but in such a case as this the loss of time represented by even one generation would have meant almost incalculable loss—material loss—to England; and very likely the Americans, or some other energetic people, would have come in, and would have taken the lead and all the glory and profit out of our hands (hear, hear). I will not go into details here, but I will state only what is publicly known when I tell you that in order to avert a failure, which would have led to the loss of all the capital employed, Sir John Pender gave his personal guarantee for a quarter of a million sterling (loud cheers). That practical evidence of confidence created confidence in other people. The work went on again; a new cable was laid, and by what I have always thought the most singular triumph of scientific ingenuity, the old cable was recovered from the depth of the Atlantic, some two miles below the surface (applause). We have heard of capital sunk in an industrial enterprise; but it does not often happen that capital sunk at such a depth is recovered (laughter and cheers). Well, if our friend had done nothing more than what I have told you he would still have been the greatest benefactor to the cause of telegraphy that had yet appeared. But with him this success was only the beginning. He was not content to win a victory—he knew how to improve it when won. He became chairman of the company that laid the first line to India; he controlled the line giving independent communication to Gibraltar, Malta, and Suez; he created the present Eastern Telegraph Company, giving access to the whole of the Levant; he was mainly instrumental in establishing communication with Australia and China; and, not least important, he gave us the cable to South Africa, which, if it had been in existence a few years earlier, would have saved us an outlay larger than I like to contemplate, both in lives and in money (cheers). No doubt he has not done these things alone. Others have helped, and helped largely (Sir John Pender: Hear, hear), but I am sure I shall not be contradicted when I say that those who have the best right to participate in the credit would be the readiest to award to our friend the largest share of it (cheers). Sir John himself will tell you better than I can do what the results of telegraphic work have been, but I think I am right in saying that the submarine cables now in use would go five times round the globe, and that more than nine-tenths of them—which to my mind is a more important matter—have been laid by private enterprise, leaving less than one-tenth as the work of the State (cheers). In regard to military matters, the saving of force effected by ocean telegraphs is obvious, and is immense. If troubles occur in India, in South Africa, or elsewhere, troops can be on the spot in less time than it would have formerly taken for the news to reach England (applause). Wherever our fleets or our armies may be, they can be put under orders from home at a few hours' notice. To any country that would be a considerable gain; to a country whose interests and responsibilities are scattered over the world, as ours are, the gain is incalculable and invaluable (cheers). But the administrative changes brought about are perhaps not less important. We have now, for the first time, an effective control over the men whom we send out to govern distant dependencies. It is something almost unintelligible to us now the way in which in the early days of Anglo-Indian history wars were entered into, treaties concluded, and territories annexed, all in the name of England, by English arms, all at England's expense, without the people at home—even those in authority—having a chance to speak on the subject. The thing was done, and in Leadenhall-street and Downing-street it was first heard of months after it had become an accomplished fact. I am bound to admit—and you may draw from the admission what inference you please—that the absolute independence and the practical irresponsibility given to our governors did facilitate the extension of our Empire (hear, hear); but nations, like individuals, prefer to manage their own affairs, and it is, on the whole, a great deal more satisfactory to know day by day and hour by hour what our agents abroad are doing, even if we do run the risk of sometimes checking and thwarting those on the spot, and interfering unwisely in local matters in deference to opinions at home. Of one thing I am sure, that the change is in the interest of peace (hear hear), and for this reason, no doubt: People on the spot when any local quarrel arises may see more clearly than we do here what is immediately before them; but they are liable to be influenced by local interests and local prejudices, and they naturally look not to the policy of the Empire as a whole, but to the policy of that small part of the Empire with which they have to do. As it affects public business there are many here who can speak to more purpose than I can; but my impression is that telegraphic communication all over the world tends to check speculation, because men act now on certain information, and not on conjecture. I think also it tends to the suppression of middlemen—to the lessening of those intermediate profits, and so, in general, to the advantage both of the producer and the consumer. That is all good as far as it goes, though no doubt it checks the growth of great commercial fortunes, and it makes business less attractive to those who have a turn for speculation. To me the chief interest in the subject lies in the absolutely new conditions of human society which telegraphs have introduced. For the first time since man existed on earth the whole human race has been brought face to face, so to speak (hear, hear, and cheers). Of course it is very hackneyed to talk about space being annihilated, but no familiarity quite takes away the feeling of wonder when one hears of men at different ends of New York, at a time when all traffic was interrupted, and the streets were blocked, and the local wires were destroyed, communicating with one another *viâ* London. That to my knowledge is a matter of fact. It is almost equally striking when one sees at the clubs the report of a battle going on somewhere in Asia or Africa, 8,000 or 10,000 miles off, and the report of that battle reaches you before the battle is concluded (cheers). Whether mankind will love one another better as they come into closer contact is an open question. I wait to see the result, but, at any rate, they will understand one another better, and that is something gained. However, I did not come here to lecture you on telegraphs or on the future of humanity. I came here to ask you, as I ask you now, to drink the health of the man to whom, more than to any other, we owe the present development of the telegraphic system of the world (cheers).

The toast was drunk with the greatest enthusiasm, the company joining in singing "For he's a jolly good fellow."

Sir JOHN PENDER, who on rising to respond was received with prolonged cheers, said: My Lord Derby, your Excellencies, my Lords and Gentlemen—Lord Derby has given to me a very pleasant task to perform, that is to present to my wife in the name of my friends a portrait of myself. I doubt whether there could be anything more pleasing for a husband to do to an affectionate and loving wife. It will afford me the greatest pleasure to make the presentation, and I believe that the pleasure she will have in receiving it from my friends may probably be the greatest she has experienced in her life (applause). Lord Derby has spoken of my early life—my early mercantile life—and of my being a self-made man. My Lords and Gentlemen, he has told you the truth and the whole truth; but when I look back to the period of my life which I spent in Lancashire, the county of which Lord Derby is so proud, and in which he is so much beloved, I may tell you that it was probably the happiest of my life. I was sowing, constantly sowing, and, I am glad to tell you, I was constantly reaping too (laughter and cheers). Probably there is nothing that affects a man more in his life than to know that when he puts his hand to anything there is a happy result to that act of his (hear, hear). I may say, I think without any hesitation, that my life in Lancashire, arduous as it was, was very happy, though very exciting. At the same time—and there are Lancashire men here, I am glad to say, who have followed my career all through—I believe that the period in which I lived in that county was probably the most remarkable in point of prosperity that it ever enjoyed. Now I pass from what I may call the first period of my life, and come to that which Lord Derby has more particularly brought before you, and which has probably more to do with the object of this gathering this evening. But when Lord Derby talks to you and to me as he has done to-night, I must say that, often as I have spoken in the interests of submarine telegraphy, I have never felt the difficulty I feel now of expressing my gratitude for the language he has used and for the reception which you have given to his remarks. It is, indeed, impossible for me to command words to express the gratitude I feel for these warm expressions of yours; but it would be altogether wrong of me were I to accept those expressions entirely to myself. I have been associated with a band of honourable and earnest men in an endeavour to accomplish a great work. We have worked hand in hand with one another, and we have, I believe, attained a great result. Why, gentlemen, it is only little more than 21 years ago since scientific men declared that submarine telegraphy was practicable. At that time a few men associated with myself took a firm grip of the question, and the result was that we carried submarine telegraphy to the position which it occupies at the present time (cheers). And what is the position it occupies at the present time? Why, this position—that there is no civilised country in the world—or there is scarcely one left out—that is not now approached by the submarine telegraph (cheers). It has brought our Indian Empire and our vast Colonial possessions into hourly touch with England. What occurs here and what occurs there are known to each alike. By submarine telegraphy war may be averted by temperate counsel promptly exercised, and due effect being instantly given to the judgment, prudence, and foresight of our statesmen. The use of the commercial capital of the world is made manifold by telegraphic communication, social intercourse is developed and widened, and the facility of our cable connection has brought us into harmony and communication with our friends beyond the seas, and in this sense it has practically created that federation which is so much desired by so many of our eminent statesmen in this country, as well as in our Colonies (cheers). In short, submarine telegraphy has brought about unity of action in all that pertains to our political, commercial, and social life. My lords

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and gentlemen, I am not going to weary you with statistics, but I may submit for your reflection that the vast commerce of this Empire, as shown by our exports and imports - involving no less a sum than 1,000 millions sterling per annum—is influenced and controlled daily, as it were, by our cable communication. Yet I repeat that it is only in its early life. It is not only the commerce of this country—it is not only the capital engaged in this country—but our system is a great international system. We have created it not for ourselves alone, for there is no nation in Europe—there is no part of the civilised world—that does not receive the same benefit from submarine telegraphy that England receives, though this country has been the initiator. My Lords and Gentlemen, we have not, as has been said, girded the world to the letter—because, I may tell you, it would not pay—we have in all this great work never lost sight of the practical and commercial value that should be taken of it—but we have done more, as Lord Derby has told you. We have laid sufficient cable to girdle the world five times round (cheers), and when it becomes practicable to complete that great prophecy we are ready to do it to-morrow. All this work has cost something like 40 millions sterling, the larger portion of which—36 millions—has been subscribed by private enterprise, and only four millions by the Governments of the world. That, I say, is one of the remarkable instances where commercial enterprise has done more to benefit the world than all the Governments of the world put together. I think I may appeal to any gentleman here associated with me in the early days of telegraphy to endorse what I am about to say. I remember when we considered it a difficult question to raise £500,000 or £600,000 to lay a cable in the Atlantic, and I know very well, my lords and gentlemen, the difficulty we had in getting that sum ; but as I have already told you there are now forty millions sterling at the bottom of the sea. As Lord Derby has said, it is very difficult, having put money there, to find how to get it back, but, taking it all round, where it has been sunk it lives (cheers), and there are many whom I am addressing, and many of the public, who will agree with me when I say that we are paying a very satisfactory dividend on the money that they have invested. I may say more. A feature which I think is a very proud one indeed in regard to submarine telegraphy is that the debentures which those companies have issued hold at the present time about as high a position in the City of London as those of any other existing company. Moreover, the nations of the world are now recognising submarine telegraphy, and since I came here I have been told by one of the members of the Board of Trade that the decision of the conference which has been held for the protection of submarine telegraphs was to be confirmed by the nations represented, and that on the 1st of May we are to be recognised by the nations of the world as a great and important institution. Now that this great work is accomplished, and communication with all parts of the world made almost a certainty, who are those that most appreciate the advantages conferred by it? I will first say that statesmen—your excellencies who sit right and left of me—will recognise that submarine telegraphy has been an important advantage to you in your positions. I would say the same also of the merchants, of whom there are many here this evening ; and as to the shipowners, they all know how we have followed the flag, and how our enterprise has developed this country's commercial relations with the rest of the world (cheers). I think there are few of them who would not admit that. I will also appeal to philanthropists. They know how much human progress has been helped by this means. Our admirals and generals will, I believe, admit—and Lord Wolseley has done so this evening—that submarine telegraphy has played and will play an important part in wars, should this country unfortunately be at any time embroiled. God grant that it may be more prominent in averting than in facilitating war. I am sure Lord Wolseley and the Admirals will say Amen to that (applause). I would also appeal to the Press. I say that the power of the Press in England is felt throughout the world by this omnipotent agency (applause). Those who hold the view that the English-speaking races will eventually dominate the world, know the impulse that submarine telegraphy has given in that direction. Social life, whether as regards the classes or the masses, has been extended, and the feeling of loyalty to the Throne and attachment to the old country has been enhanced. The whole scope of good which I have briefly indicated carries its own reward to myself and those with whom I have been associated (cheers). So much for the past, or what I may call the early youth of submarine telegraphy. There are yet great questions to be solved in which submarine telegraphy is likely to play an important part. One of these is the disposal of our surplus population. We have in the past by that surplus population created colonies that are to some extent our wards. Those colonies have to be extended, and telegraphy will play an important part in doing so and sweetening and quickening emigration (applause). There is nothing probably that retards it more than the feeling of regret at leaving the old home and the old country ; but they know that through the Press they will be able to ascertain what is going on at home and all about the old surroundings, while those that are left behind will know that they will be made acquainted almost from day to day, if not from hour to hour, with what is taking place at the new homes of the emigrants. This will make our surplus population brace themselves up to leave the mother country, knowing, as I have said, that they will hear from those they leave behind, and knowing that they are going to countries where they will have elbow room and a chance in life. That consideration is of great moment at the present time to England, and of enormous importance in the future, because such emigration will create an England abroad—a people that will always be loyal to the old country (cheers). Now, let me add that the mission of submarine telegraphy is peace (hear, hear, and applause). It is beneficent in this, that its object is to advance civilisation—its object is to bring about political, commercial, and social progress. And let me say that I believe when the history of the Victorian era is written submarine telegraphy will take a very important position in its records (applause), and those friends who are associated with us—friends in England, friends in Germany, friends in America—will all have the satisfaction of knowing that they have taken part in a work which has promoted the progress of the world, and they will feel satisfied that in taking part in that work they have left the world more advanced and more in harmony than they found it (loud cheers).

The MARQUIS of TWEEDDALE: My Lords and Gentlemen, a very important toast has been entrusted to me this evening, which I am sure will receive from you a very hearty reception. The toast which I have to propose is no less a one than "Prosperity to the British Empire" (cheers). My Lords and Gentlemen, this is a toast on which much might be said, but having regard to the period of the evening at which we have now arrived you will not expect from me a long speech. I shall not dwell in dealing with it upon the marvellous extent to which our Empire has reached, embracing, as it does, one-sixth of the whole surface of the land of this world, and embracing no less a proportion of the peoples of the world. Nor will I dwell upon the energy and the enterprise which have led to the acquisition of that enormous Empire. These are matters which are familiar, or ought to be familiar, to everyone here, but I think I may be allowed to express the hope that we are not wanting in ability to maintain that Empire or in the desire to transmit it intact to those who come after us (cheers). It has often been said that it is very easy to acquire an empire, but very difficult to maintain it. History affords innumerable examples of enormous empires which have been acquired, and which have been as speedily lost; and there never was a time, I venture to think, in the history of this country when the lessons which have been thus learned were more important than they are at this moment (applause). Everyone who has paid any attention to what is going on in the world must have observed the immense interest which has been taken by foreign countries in the development of their Colonial possessions and the acquisition of new territories ; and I do not think we should be surprised if foreign nations should view, if not with envy, certainly not without some regret, the opportunities which they have lost in placing themselves in the same position as we have with respect to the world at large. This remarkable awakening on the part of foreign nations to the desirability of securing possessions and colonies throughout the world should, I think, arouse in us a desire to protect and preserve those possessions which we have acquired through the energy of those who have gone before us. Happily in this country, simultaneously with that movement which has been so marked in foreign nations, an immense change has taken place in this country in popular sentiment with respect to our position in the Colonies and our dependencies. Within the last few years a predominant school in this country advocated the principle that our Colonies should be allowed to shift for themselves without any regard to the mother country. When we talked about India the answer was, "Rather let India perish than that we should incur any great risk in its defence." I am happy to say that the school which held these views is now almost extinct (applause). On the contrary, you will see on every hand those who are advocating a very much closer alliance, a much closer connection with our Colonies and dependencies abroad than ever before in the history of this country (hear, hear). I am not going to discuss the various proposals which have been made from time to time in recent days to strengthen the ties which exist between us and our Colonies and dependencies. Some of these proposals appear to me to be very desirable, others appear to me to be rather fantastic, but in this I feel perfectly sure you will agree with me, that of all the means advanced to strengthen the ties which exist between us and our Colonies and dependencies, none have been so entirely free from any objections and so entirely advantageous to them and to us, as the establishment of that connection which has been produced by the institution of telegraphic communication between us (cheers). And when I ask you to respond to this toast, as I shall do at once, I hope you will not forget the immense share which has been taken in promoting this important and valuable enterprise by the gentleman whom we are here to honour on this occasion (applause). I think you will all reflect when you drink this toast, that no one has done so much—no statesman has done more—to establish an intimate connection with our Colonies and dependencies than the gentleman to whom I have referred (renewed cheers). I ask you now to drink to the toast of the "British Empire," connecting with it the names of two distinguished gentlemen, Sir Selwin Ibbetson, M.P., and Sir Arthur Blyth.

The toast having been duly honoured,

Sir H. SELWIN-IBBETSON, M.P., said we might well be proud of our country, considering the prominent position she had attained. England had become a great and strong nation through her commerce and the character of her people. Looking at the past history of the country, we could see how she had steadily and gradually by her commerce and enterprise spread her net over the world. That net and that spread of country was a guarantee, at all events—and a large guarantee—for the maintenance of peace, and nothing so much pointed to that conclusion as such a gathering as the present, which was to pay a tribute to the success of an Englishman—one of the type of men who had won for us our proud position (cheers). The British Empire might rest confident in her strength and in her future as long as such men remained among us to rule her destinies.

Sir ARTHUR BLYTH having also replied,

LORD ESHER proposed "The Health of the Chairman," which was drunk with great cordiality.

LORD DERBY, after acknowledging the compliment, alluded to the receipt of the following, among many other telegrams :—

ADELAIDE (from Mr. CHAS. TODD, C.M.G.).—"Australian friends add their heartiest felicitations to those tendered to Sir John Pender, K.C.M.G., at banquet to-night."

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ALEXANDRIA (from Blum Pasha).—"Please receive my heartiest congratulations on the occasion of the so-well-deserved distinction conferred upon you."

ALEXANDRIA (from Nubar Pasha).—"I join all good friends united with you this evening in sincere congratulations."

ATHENS.—"Prime Minister, Miss Tricoupis, Mr. Lombardos, and all here send you their most hearty congratulations, trusting that the well-merited honour conferred upon you is only a foretaste of still higher ones."

BERLIN (from Dr. Lazard).—"Most sorry not having been able to accept kind invitation. I beg to express my full sympathy with the object of the banquet, and best wishes for Sir John Pender's future health and happiness.

BOMBAY.—"Lord Reay sends his sincere congratulations to Sir John Pender."

CAPETOWN (from Mr. James Sivewright, C.B.)—"Sincere and hearty congratulations from Capetown."

CONSTANTINOPLE (from Izzet Effendi, Director-General Ottoman Telegraphs, G. Serpos Effendi, Mr. A. de Vere and Staff).—"Constantinople begs to join her congratulations to those which are to-day offered to you by London."

COPENHAGEN (from the Chairman and Managing Director of the Great Northern Telegraph Company to Lord Derby).—"From the land in which the mighty powers of electro-magnetism first came to light, powers which were soon enrolled into the service of telegraphy, we send a warm greeting of sympathy with the banquet given in honour of Sir John Pender, K.C.M.G., through whose energy and perseverance, aided by the skill of congenial co-operators, so many of the most distant parts of the globe now enjoy instantaneous communication with each other. We trust and hope that continued cordial telegraphic relations will more and more result in benefits to the world at large."

DURBAN (from Mr. Henry Carlisle).—"Staff in South Africa respectfully tender congratulations to their Chairman."

MADRAS.—"Lord Connemara sends you cordial congratulations."

MALTA (from Mr. Robert Portelli).—"His Excellency the Governor desires me to convey to you his hearty congratulations on your well merited honours, and wishes you may live long to enjoy them."

ZANZIBAR (from the Sultan of Zanzibar).—"We congratulate you on decoration invested by Queen Victoria, hoping you will wear it happily and long."

ZANZIBAR.—"The station and 'Great Northern' united in offering warmest congratulations to Sir John Pender this evening, and hoped for long-continuance of the life he has so successfully devoted to ruling the destinies of the electric telegraph."

NEW YORK (from Mr. Norvin Green, President of the Western Union Telegraph Company, and Mr. Thos. T. Eckert, General Manager, to Lord Derby).—"Pray add our congratulations to the many which are doubtless coming from all parts of the world to Sir John Pender, on the occasion of this public recognition of his long identification with the cable enterprises which have contributed so large a share to the advancement of civilisation. We wish Sir John and Lady Pender long life and much happiness."

NEW YORK (from the President of the Dominion Telegraph Company of Canada to the Earl of Derby).—"Pray allow me to give expression to my feelings of gratification at the presentation to be made at the banquet this evening by your lordship and friends to Lady Pender, in commemoration of the honour which Her Majesty has so graciously bestowed upon Sir John Pender in recognition of his valuable public services."

NEW YORK (from Mr. E. Wiman to Lord Derby).—"As representing the telegraph systems included in the Great North-Western Telegraph Company of the Dominion of Canada, and extending all over the northern continent, permit me to tender my hearty congratulations through your lordship to Sir John and Lady Pender on the occasion which calls their friends together. Though distant from Sir John thousands of miles, nevertheless we maintain a close connection, and realise every day the vast service he has rendered the world in promoting instantaneous communication throughout its wide expanse. Kindly ask your honoured guests to accept the compliments and kind regards of our telegraphic circle."

NEW YORK (from Mr. Cyrus W. Field, to Lord Derby).—"Will your Lordship kindly convey to Sir John Pender my warmest congratulations and my regret that, living at my home in New York, I am unable to be present this evening at the banquet given to him by his many influential friends and admirers, and my consequent inability to take him by the hand and to assure him how much I appreciate his valuable services in connection with ocean telegraphy?"

NEW YORK CITY (from the Mayor to Lord Derby).—"Pray express to the assembled guests the great gratification which the American friends of Sir John and Lady Pender feel in the honours which are paid to them by their admirers, among whom please count as the most sincere Mrs. Hewitt and myself."

THE PROTECTION OF SUBMARINE CABLES.

The Board of Trade have called the attention of the Submarine Telegraph Companies of this country to a notice which appeared in Tuesday's *Gazette* relating to the International Convention for the Protection of Submarine Cables :—

NOTICE.

Submarine Telegraph Act, 1885.

(48 and 49 Vict., cap. 49.)

WHEREAS by the Submarine Telegraph Act, 1885, it is (amongst other things) enacted as follows :—

"This Act shall come into force on such day as may be fixed by a Notice in that behalf published in the *London Gazette*."

Notice is hereby given, that the day fixed for the said Act to come into force is the first day of May, 1888.

Henry G. Calcraft.
Secretary to the Board of Trade.

Board of Trade, April 20, 1888.

The full text of the Act above referred to will be found in *The Electrician*, August 7th, 1885, page 233.

DAMAGED BY LIGHTNING.

The accompanying sketch, from a photograph taken by Mr. W. Marriott of objects exhibited by the Royal College of Sur-

geons at the recent exhibition of the Royal Meteorological Society, represents a suit of clothes which were torn from the body of a labourer while standing under a tree near Ashford, Kent, during a severe thunderstorm on the 8th June, 1878. They comprise a cotton jacket, flannel under-vest, trousers, stockings, garters, boots and watch. The man was thrown some distance from the tree, while his clothes were hurled in all directions. The poor fellow was not killed, but was rendered insensible; he is still alive, and naturally has a very great dread of thunderstorms.

BOOKS, &c., RECEIVED.

"Researches on Diamagnetism and Magne-Crystallic Action" (New Edition). By John Tyndall, D.C.L., LL.D., F.R.S. (London : Longmans, Green and Co. 1888.)

Report on "Tests of a Griffin Patent Double-Acting Horizontal Gas Engine," by Andrew Jamieson, M.I.C.E., F.R.S.E., &c.

"Catalogue and Price Lists of the 'Otto' Gas Engine." (Crossley Bros., Manchester.)

"*Modern Light and Heat* Pocket-book." (Boston, Mass.)

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OBITUARY.

THOMAS RUSSELL CRAMPTON.

We regret to have to record the death of Mr. T. R. Crampton, M.Inst.C.E., which occurred at his residence in Ashley-place, Westminster, on the 19th inst. Mr. Crampton will be remembered as having successfully laid one of the first cables which connected England with France in the year 1851, a task the whole engineering responsibility of which devolved upon him. Mr. Crampton's other achievements were chiefly in the field of railway extension; but he continued to take interest in telegraphic engineering, and was at one time a member of the Council of the Society of Telegraph-Engineers and Electricians. Mr. Crampton was seventy-one years of age, having been born in 1816 at Broadstairs, Kent.

SAUNDERS' LIGHTNING GUARD.

In our issue of February 24th last we mentioned a recent instance in which a lightning flash struck the cable station at Porthcurno and fused the coils of two recorders, the only lightning protector in the station which proved efficient being one of the form devised by Mr. Wm. Saunders. Under these circumstances this form of protector is likely to come into more extended use, and the following description will therefore prove of interest:—The Saunders lightning guard consists of a brass tube, B (Fig. 1), through which passes a fine wire, W, one end of which is attached to the terminal C, and the other to a stud passing through and moving freely in the terminal C′. The spiral spring S is held in tension by the wire. The consequence is that when the fine wire is fused by lightning the spiral spring S is released, and the stud makes contact with the screw E, which with the tube is connected to earth, thereby putting the cable to "earth." The plugs A A at each end of the tube are for the purpose of bringing the line and "earth" as near together as possible. They are shown separately in Fig. 2, which also gives a transverse section of the instrument.

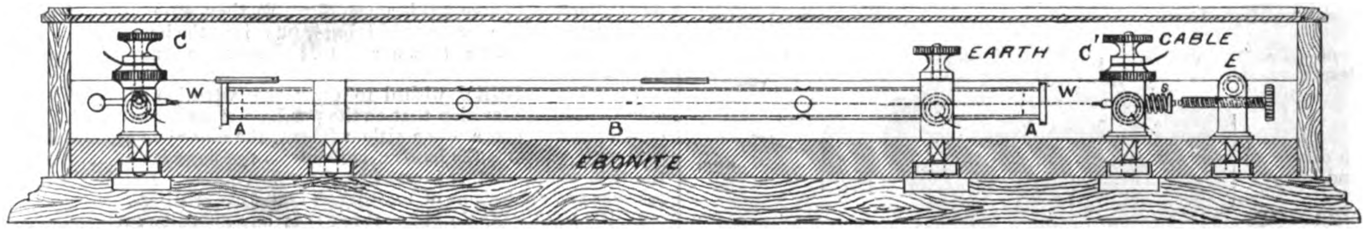

Fig. 1.—Saunders' Lightning Guard.

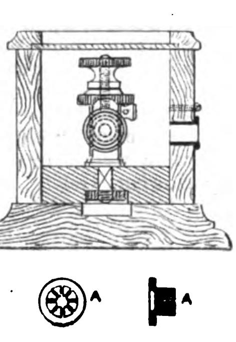

Fig. 2.

All the parts are mounted on a vulcanite base—to give good insulation between line and "earth," &c.—covered with a glass-top case.

NEW AUTOMATIC FIRE ALARM.

A new automatic fire alarm, based upon the expansion of air, is being introduced by the "Patented Appliances Company," and is shown in the adjoining cut (Fig. 1). It consists of an air chamber

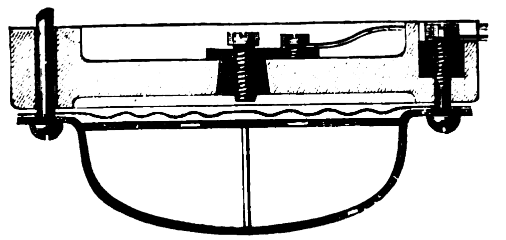

Fig. 1.

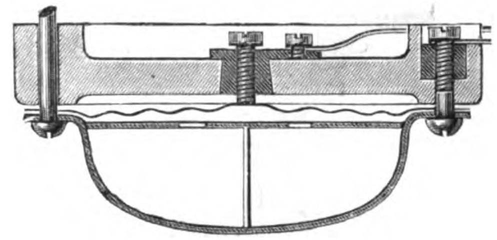

Fig. 2.

heremetically closed by a corrugated metal plate, similar to that used for an aneroid barometer. When the temperature rises to a certain point the expansion of the contained air brings the metallic plate in contact with screw, as shown in Fig. 2. This closes an electric circuit, which rings a bell, and operates an indicator in the usual manner.

NEW ACCUMULATOR AND ELECTROLIER SWITCHES.

We illustrate herewith (Fig. 1) a switch made by the Woodhouse and Rawson Electric Manufacturing Company (Limited) for enabling

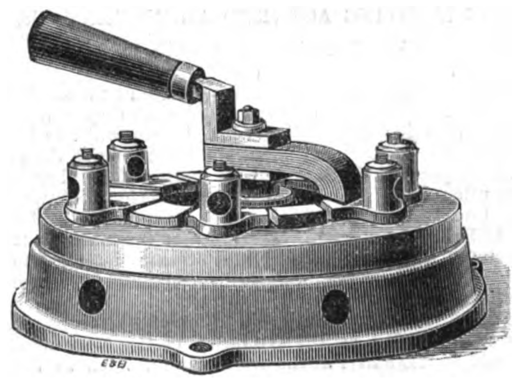

Fig. 1.

extra accumulators to be placed in or out of circuit during charge or discharge. The short-circuiting of a cell is prevented by a coil of wire of any suitable resistable mounted on a vulcanised fibre frame below the slate base, the whole switch being fixed on a hollow cast-iron frame, which is perforated in several places to allow a free current of air to pass, and it is so made that it can be

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firmly screwed in any position. The brush is composed, in the usual way, of a number of independent bent plates of brass, and the instrument is well finished, while the work throughout is of the firm's usual high-class quality. These instruments are made in several sizes, according to the current required, and we understand have already been supplied, not only in England, but also to several Continental installations.

We give also illustrations (Figs. 2 and 3) of an exceedingly neat switch for use in brackets and electroliers which Messrs. Woodhouse and Rawson are now selling largely. Its arrangement is somewhat similar to their ordinary small "G" type spring break switch; it is very compact and easy to wire. The outer case has been hollowed out, so that one wire may be easily passed through,

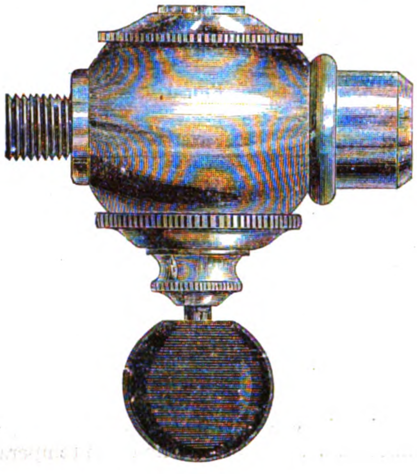

Fig. 2.

Fig. 3.

and the whole of the switch itself can be removed by unscrewing without interfering with either holder or bracket.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.—MONDAY, April 23.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 1) BILL.

The House went into Committee on this Bill.

On Clause 2,

The EARL OF CAMPERDOWN moved to omit the words "the goodwill of the business and of" on the ground that they rendered uncertain the elements of value in the property of the companies to be taken over. He desired at the same time that at the expiration of the period during which the companies' privileges were to endure their plant and material should be valued as being *in situ* and as suitable for the purposes for which they were intended, instead of being taken over at the "old iron" value.

The EARL OF CRAWFORD observed that inasmuch as it was understood that the noble and learned lord opposite intended to propose an amendment upon this clause, it would be convenient if he would now state the effect of that amendment.

LORD HERSCHELL said that the effect of his proposed amendment would be to insure that at the expiration of the companies' term their plant should be taken over at the price it would fetch as being ready for immediate working.

VISCOUNT BURY hoped that the word "goodwill" would not be omitted from the Bill. When the measure was before the Select Committee the Committee appeared to be divided into two parties—one in favour of giving the companies a right to the value of their goodwill, and the other in favour of treating their businesses as those of breaking-up concerns.

The EARL OF CRAWFORD said that in justice to the public they should make it clear when the companies would no longer be justified in putting fresh capital into their works for the purpose of keeping them in going order.

The MARQUIS OF SALISBURY confessed that his first view with respect to a matter of this kind was that if compulsory powers for purchase of a going concern were enacted the full value of the going concern at the time of purchase ought to be given. He did not see that there was any reason why the electric lighting companies should be burdened with burdens different from those placed upon other industries; but as he understood that the companies themselves were willing that those words should be left out, the House would be justified in agreeing to the motion. He should, however, reserve to himself the right of voting in a contrary sense on any subsequent occasion. At the same time he wished to state that he did not assent to the view either on the one hand that this industry should be subjected to greater burdens than were imposed upon others or on the other, that they were entitled to any special preference.

LORD HERSCHELL observed that he agreed with very much that the noble marquis had said. He had always thought it desirable to provide against unreasonable terms being required if the local authorities wished to purchase these undertakings; but he had never seen any reason why special burdens should be imposed upon the undertakers. If the condition were imposed upon them that at the end of any given term they should not receive the full value of the property they would recoup themselves in some other way, as by making higher charges. The present generation would thus pay more for the electric light in order that some thirty or forty years hence the next generation should have it for less than ought to pay. At the same time he recognised the difficulties of the situation, and if the Bill could not be got through without, he agreed that the word "goodwill" should be struck out of this clause. He would prefer that instead of the term "goodwill" the words "market value" should be substituted.

LORD THURLOW said he was quite willing to assent to the motion. It was essential for the passage of the Bill through another place that the word "goodwill" should not be in it. What he dreaded was that unless the purchase of these undertakings was made a fair one—and more than fair, liberal—during the last few years of the term the undertakers would be tempted to do what was called scamp the undertaking. He had consulted the representatives of most of the London and provincial electric lighting companies, and he had come to the conclusion that the prolongation of the term from 21 to 42 years, as now proposed, would be sufficient to insure the public against overcharge. On behalf of the companies he was authorised to accept this amendment, as they were satisfied that the prolongation of the term would bring capital into the business.

The amendment was then agreed to, as were some consequential amendments.

VISCOUNT BURY wished to draw the attention of the noble lord opposite to the provision that on the purchase of an undertaking the purchaser should get a clear title without the seller having to make one. This would absolve the local authority from the necessity of investigating the title to see whether it was free from mortgages He should like to ask what would become of mortgagees and other creditors.

LORD THURLOW did not think that any difficulty such as that suggested by the noble viscount would arise. At the same time he might say that he was not responsible for these words in the clause.

The clause was then agreed to.

The other clauses were also, with some amendments, agreed to, and the Bill passed through committee.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

STUDENTS' MEETING.

A students' meeting was held on Friday, April 20th, in the Society's Library, Mr. Alexander Siemens, vice-president, in the chair.

Mr. E. George Tidd read a Paper upon "The Use of Electricity for Theatre Lighting." The writer, in his opening remarks, pointed out the advantages of the light in our public places of entertainment and the practical methods of working it. He then proceeded to give a full and detailed description of the installations in our various London Theatres. The writer stated that the following ten theatres and music halls were wholly or partially lighted by electricity, viz.:—Savoy, Criterion, Gaiety, Prince of Wales, Haymarket, Terry's, Pavilion, Alhambra, Oxford, Empire, and that now it was in process of installation at the Adelphi. He considered the Criterion and the Savoy the most perfect examples, their plant having worked satisfactorily without any break or interruption, the former for over four years and the latter for seven years. Of the remainder, six have the current supplied from the Grosvenor Gallery, and the Alhambra and Pavilion have plant of their own, but only employed for lighting the auditorium. He referred to the Oxford as the most recent specimen of wiring, following the Fire Office Rules as closely as possible.

The Paper was illustrated by diagrams and by apparatus kindly lent by Messrs. E. L. Berry and Co.

A discussion followed, in which Messrs. Sanders, E. W. Smith, Dykes, Rance and Lamb took part, and after Mr. Tidd's reply, the chairman made a few remarks and the proceedings then terminated.

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THE VARIATION OF THE COEFFICIENTS OF INDUCTION.*

BY W. E. SUMPNER, B.SC.

The coefficient of self-induction of a coil whose magnetic circuit is wholly or partially composed of iron is such a variable quantity that it is necessary to define its meaning more exactly than has hitherto been done. Of the many definitions possible, to give the best is probably that according to which it is the ratio of the induced electromotive force to the rate at which the current is changing. Since the induced electromotive force is equal to the rate at which the magnetism is changing, the ratio in question is the rate at which magnetism changes with the current. From this it follows that if a curve be drawn whose abscissæ represent the current, and whose ordinates represent the amount of magnetism or the number of lines of force enclosed by the coil, the coefficient for any particular current will be represented by the rate of slope of this curve. The shape of these curves is well known from the researches of Prof. Ewing, Dr. Hopkinson and others. They are generally such that as the current increases the curve slopes very gradually

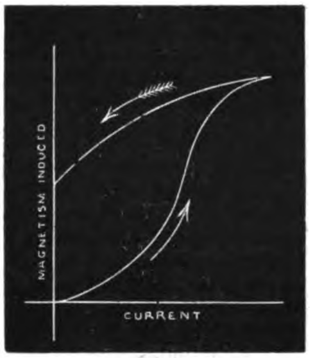

Fig. 1.

at first, but becomes steeper and steeper until the current begins to saturate the iron. The curve then bends over, and the slope becomes ultimately small. When the current is diminished the curve of magnetism, owing to magnetic hysteresis, does not return on itself, but is such that it becomes steeper and steeper as the current is diminished. Fig. 1 shows the general shape of the curve connecting the induced magnetism with the current. The arrows indicate the way in which the current is changing. Fig. 2 is a curve drawn from Fig. 1, and is such that the ordinate for any

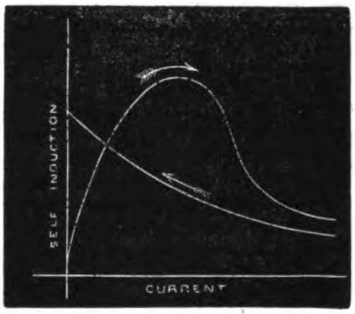

Fig. 2.

particular current represents the rate of slope of the curve in Fig. 1 for the same value of the current. The coefficient of self-induction for increasing currents at first increases and then diminishes, while for decreasing currents it is small at first and steadily increases as the current is brought to zero.

Many experiments made on an electro-magnet, on the field-magnets of dynamos, and on a Kapp transformer have completely confirmed these conclusions. Owing to magnetic hysteresis the number of lines of force enclosed by the coil will depend not only upon the current flowing at the moment, but also on those that have been flowing previously. The value of the coefficients will for the same reason depend on the former magnetising forces, and may be obtained of almost any value by using suitable magnetising currents before determining its amount. The coefficient for an increase of current will always be different from that for a decrease of current. These effects of hysteresis were obtained in all the experiments made, and were very marked in the case of a Kapp transformer. Several methods were used for determining the coefficients. The chief were Maxwell's absolute method, and a modification of it by Prof. Ayrton, a comparative method (due to the author, see *Electrician*, June 24, 1887), by which the coefficient was found in terms of the capacity of a standard condenser and the secohmeter of Profs. Ayrton and Perry.

There is a simple graphical method for determining the current flowing at any moment when the electromotive force is given at each instant, and the coefficient of self-induction is given for every value of the current. In the case of a simple circuit the following equation holds true,

$$E - L\frac{dC}{dt} = RC,$$

where C is the current, E the electromotive force (which is not necessarily constant), L the coefficient of self-induction, and t the time.

It follows that

$$\frac{dC}{dt} = \frac{\frac{E}{R} - C}{\frac{L}{R}} = \frac{C_o - C}{\frac{L}{R}}.$$

Now, $\frac{E}{R}$ is what the current would be if there were no self-induction, and is given we suppose for every moment. Call it C_o and plot a curve having C_o for ordinates and time for abscissæ. Plot another curve having current for ordinates and the corresponding value of $\frac{L}{R}$ as abscissæ. If L is given in secohms and R in ohms, L/R will be in seconds, and must be plotted to the same scale as for the former curve. It will be found best to plot the values of L/R in the negative direction, as in Fig. 3.

The construction is then as follows:—Suppose P_1 be the given

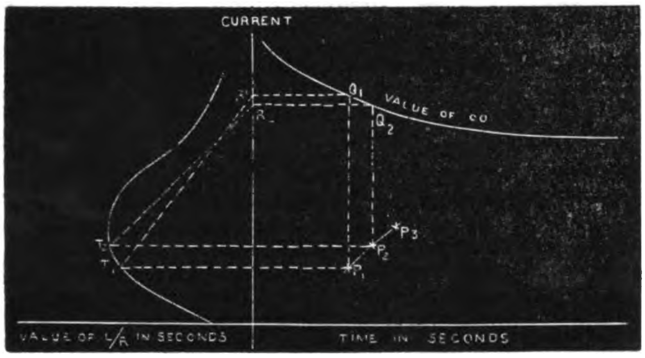

Fig. 3.

initial point on the current curve. Project it horizontally and vertically to the points T_1 and Q_1 on the curves for L/R and C_o; project the point Q_1 horizontally to R_1 on the current line. Draw from P_1 a line parallel to the line $T_1 R_1$, and choose a point, P_2, on it not far from P_1. The point P_2 may be considered as the next point on the current curve, and the process which is indicated in Fig. 3 may be repeated for the point P_2 to get a third point, P_3, and so on, until the whole curve connecting current and time is obtained.

The curves have been drawn for several cases of steady and alternating currents, and have yielded some interesting results. If the coefficient L is a variable the time taken to establish a given portion of a steady current will vary with the amount of the current to be established. The current may increase at very different rates during the rise, and may hasten and slow and hasten again while increasing in a very remarkable manner. Prof. Thompson has observed some of these effects experimentally. The general effect of the variation of L is to introduce ripples into the curve of current obtained by assuming that L is constant, and equal to the mean of the different values. It is generally assumed in calculations connected with alternating currents that the E.M.F. of the dynamo is a sine function of the time, and that the coefficient L is a constant quantity. Although these assumptions are well known to be inaccurate they are generally believed to be sufficiently true for practical purposes. It is very doubtful whether this is the case. Experiments made on the Ferranti dynamo at the Central Institution have shown that the electromotive force curve is such that its ordinates differ from those of the most favourably drawn sine curve by as much as ±5 per cent. With other dynamos probably much greater variations occur. Probably also with some dynamos the curve of electromotive force is more like that which would result from the sum of two sine curves, one with a period corresponding with the current alternations, and the other with a period coinciding with that of the

* Abstract of Paper read before the Physical Society of London, April 14, 1888.

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dynamo revolutions. This will occur whenever there is want of symmetry in the machine, and this effect will be much magnified in the current curve if the self-induction is large and the alternations very rapid. That alternating currents are not generally simple sine waves seems to be indicated by the well-known pulsations to which electric lights fed with alternating currents are subject. These pulsations are too slow to be due to the ordinary current alternations, but might be in time with the revolutions of the dynamo. They are so marked in the case of one important London installation that Mr. H. B. Bourne has observed that a rapidly moving object does not present a continuous blurred appearance as if under the action of a steady light, but discontinuous images, so that, in fact, if a walking stick be swayed rapidly to and fro, the appearance is as if there were five or six instead of one only.

It does not appear to have been noticed that self-induction, although always delaying the rise or fall of currents, may sometimes hasten the discharge of a condenser. The current which discharges a condenser has both to rise and fall. The self-induction will never delay the rise so much as it delays the fall, because in the former case the potential difference of the condenser is high, while in the latter it is low. If the self-induction in the discharge circuit be not too large, the condenser will discharge quicker than if no self-induction were present, and it will always be possible to halve the time of discharge in this way. As a lightning discharge is essentially the same as that of a condenser, it seems probable that a lightning conductor will be only improved by the insertion of self-induction. Dr. Lodge has recently shown that an iron conductor is preferable to a copper one, and has accounted for it by supposing that the iron conductor has less self-induction than the copper one. It is impossible at present to say whether this is so or not, but the effect may be due to a quite opposite cause.

DISCUSSION.

Prof. PERRY considered Mr. Sumpner's Paper one of the most valuable which had recently been read before the Society. With regard to the lessening of ripples in the E.M.F. curve, or the fact that if the E.M.F. function is only approximately represented by a sine-curve, the current-function will approximate more nearly to such a curve he observed that he had found it impossible to discuss the effect except by the aid of actual numerical examples. While making some determinations of this kind with his students, he had obtained some remarkable results. As an example of the e he mentioned that when the E.M.F. curve was that due to a simple make and break contact, and therefore of the form shown at A A′ in the diagram, Fig. 4, the current function where there was great self-

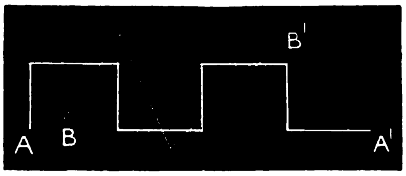

FIG. 4.

induction was represented by a curve which was not symmetrical with respect to the curve A A′, and which approximated to the form shown at B B′, when the self-induction increased definitely. It follows from those experiments that a transformer does not diminish the ripples indefinitely, but that the diminution tends towards a fixed limit.

Mr. EVERSHED observed that at the recent discussion on transformers at the Society of Telegraph-Engineers he had stated that he had arrived at a similar conclusion, and obtained a curve of the same form as Prof. Perry in the case of infinite self-induction. He had pointed out particulaly that the large ripples do not tend to disappear, but only the small ones, and also that a zig-zag E.M.F. curve does not give a current which can be even approximately represented by a sine-curve. Captain Cardew, he said, had also stated that a sine-current in the primary does not give a sine-current in the secondary. For making these statements, however, Mr. Evershed observed that he had been promptly sat upon by Prof. Perry.

In reply to Mr. Evershed Prof. PERRY pointed out that at the discussion at the Society of Telegraph-Engineers Mr. Mordey asserted that the ripples are increased by the transformer—a statement which is entirely wrong. In conclusion, Prof. Perry stated that the actual shape of the curve representing the current function had as yet not been determined experimentally in any case, and it was most important such determinations should be made.

Long-Distance Telephony in Austria.—It is stated the Austrian Telegraph Department is about to undertake the construction and working of a telephone line between Vienna and Buda-Pesth.

SYNCHRONOUS MULTIPLEX TELEGRAPHY.

[The following communication from Mr. P. Delany has been in our possession for some time, but owing to the great pressure on our space we have been unable hitherto to find room for it.—ED. *E.*]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I beg the privilege of your columns to reply to a series of articles by Paul La Cour on "Synchronous Multiple Telegraphy," recently reprinted in the *Electrical Review* (from the *Journal* of the Franklin Institute). Several communications to the same journal from this gentleman's friends have appeared previously, but I gave them no attention. My silence has apparently lured Mr. La Cour into a repetition of the misrepresentations put forth by his friends.

If the report of the Franklin Institute had been published in England in full I would not now deem it necessary to take notice of Mr. La Cour's claims, thoroughly investigated and disposed of as they have been by that honourable body. But as only disconnected extracts have been allowed to appear in the *Review*, I am forced in the interest of truth and in justice to myself to review Mr. La Cour's latest statements.

In the first article of the series in the *Review*, September 30th, 1887, Mr. La Cour gives a history of the phonic wheel, the same as published in his pamphlet, *La Roue Phonique*, in 1878. I have always endeavoured to give Mr. La Cour full credit for the invention of the phonic wheel, and in numerous patents and printed descriptions of my synchronous system I have praised that instrument, and stated that my synchronous system was based upon it. It is with much surprise, therefore, that in the *Electrical Review* of November 4 I read a communication from a distinguished gentleman describing an instrument "nearly identical" with La Cour's, constructed by him in 1874-1875 and exhibited, with a detailed statement of the theory of its operation, at a meeting of the Physical Society on the 30th of March, 1878, and published in *Nature*, May 23rd, 1878.

It would appear from this that in reaching out for credit to which he is not entitled Mr. La Cour imperils that which silence would have secured to him.

Lord Rayleigh has not yet claimed my synchronism nor my multiplex telegraph system, although his claims would be about as valid as La Cour's.

La Cour, in proof of the success of his attempts at synchronism, refers to the tests of his system in 1880 between Fredericia and Nyborg, Denmark, a distance of forty miles, and the Danish officials of the telegraph certify to the results of the trials. The Director of Telegraphs, in his reply to the Franklin Institute inquiry, says he did not see the experiments himself, but that he is "in possession of a diary" held by an officer of the Danish Telegraphs, wherein it is stated that "during that time, from the 17th of June to the 10th of July, 1880, the phonic wheel in Fredericia and Nyborg was working every day from eight or nine in the morning to nine in the afternoon only with a few interruptions, such as disturbances on the telegraph wire or mechanical disturbances on the phonic wheel. From the period from the 22nd of June to the 10th of July it is expressly remarked that the synchronism was good." The Director further states that he is in possession of official reports which show that on the 27th of June, 1880, "were sent over one wire from 9 hours 57 minutes to 10 hours 19 minutes, simultaneously, four messages on each of the *two* circuits, from Fredericia to Nyborg, 80 words on the one and 77 words on the other circuit. From 10 hours 20 minutes to 10 hours 36 minutes, simultaneously, four messages on each of the two circuits, Nyborg to Fredericia, 68 words on one circuit and 63 on the other. From 10 hours 48 minutes to 11 hours 2 minutes, simultaneously, four messages, 65 words, from Fredericia to Nyborg."

By "simultaneously" the Director evidently means at one sending or in succession, for but two circuits were operated simultaneously.

Now, let us see what these results amount to. I cannot more clearly analyse them than by quoting from the report of the Franklin Institute Committee :—

"In the first test, lasting for twenty-one minutes, eighty words were sent on one circuit and seventy-seven on the other circuit, or an average of less than four words per minute on each circuit; or, say, eight words per minute for the whole wire. The second test gave about the same average, and the third test a slightly larger one—say, nine words per minute for the whole line.

"These experiments were made at the home of La Cour, and presumably under his supervision, and it is fair to assume that the record made was of the best performance of which the system was capable. What do the tests show? Why, most conclusively that there was no synchronism nor even an approximate synchronism. This committee is familiar with the fact that a single wire with one circuit is equal to the transmission, by the Morse system, of from forty-five to forty-eight words per minute, the limit of the ability

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of expert operators to manipulate the key; and that the same wire, if duplexed, is equal to the transmission of twice as many words, and the multiplex system of Delany of six times as many words. It appears, however, that the record of the best performance of La Cour's apparatus shows but nine words per minute for both of the so-called circuits, *only one-fifth of what the wire was capable of performing as a single circuit*, or one-tenth of what it ought to have accomplished with duplex circuits. It shows that the words actually sent and received were caught by the lucky operator during the brief moments when the instruments had drifted together and before they had separated again; and it may be remarked here that the more they were out of synchronism the oftener they would drift together."

Thus, Mr. La Cour exhibits as the best performance of what he terms "perfect synchronism" during a test of twenty-three days, over a line forty miles in length, a few hours of working during which *two* circuits were operated at a speed of about four words per minute each, or nine words per minute for the entire wire. This synchronous duplex worked up to about *one-fifth* the efficiency of an ordinary simplex wire, or *one-thirtieth* of the efficiency of my present sextuplex system on a 100-mile circuit now in daily practical operation, or one-fortieth of what may be accomplished any day with my system as an octuplex on a 40-mile line.

Moses G. Farmer, of America, was probably the first to employ a single conductor for simultaneous transmission, U.S. patent 9,634, March 29th, 1853. Mr. Farmer attached to each end of a line a rapidly revolving commutator or distributor. Meyer followed with his system in 1871, and Bandot in 1874, each with revolving contact fingers for the transfer of the lines from one operator's instrument to another. Mr. La Cour will not presume to compare the results obtained by him with the operation of these synchronous systems many years before him. His perfect synchronism of 1880 was probably the most imperfect, judging from the official reports of the results that had been attempted up to that time. According to Mr. La Cour's explanation of his system, I contend that synchronism between Nyborg and Fredericia was impossible.

It is ridiculous for him to persist in asserting that he had synchronism on the occasion referred to, and with all due respect for the Danish telegraph officials, I am forced to the conviction that they were mistaken in supposing they had synchronism. Their desire for success, and commendable friendship for the effort, led them into too liberal allowances.

As I have already pointed out in my communication to the Franklin Institute, synchronism under such conditions was and is a physical impossibility.

At one station a fork made and broke automatically its own circuit through a local battery at the rate of about ninety times per second. This fork rotated a phonic wheel, the trailing arm of which made contact with numerous segments placed in the path of its rotation. With six of these segments a main battery was connected. At the distant station was placed another fork and phonic wheel. This fork was not vibrated by a local battery, but was connected to the six segments corresponding in position to the six battery-connected segments at the sending station, and was therefore to be rotated by the six impulses which came over the line at each rotation of the trailer at the first station, numbering in all about 18 per second, *provided the second phonic wheel was first in synchronism* with the first phonic wheel; otherwise the impulses coming over the line could not be delivered to the fork magnet. Therefore the fork could not vibrate, nor could the distributor revolve. With these eighteen impulses over a line the second fork was expected to vibrate in synchronism with the fork at the first station, which made for itself automatically ninety vibrations per second. Synchronism was first to be obtained by spinning the wheel by hand in order to get the fork at the second station to vibrate at all, and when once in vibration this fork, with eighteen impulses per second, coming over a line, was to vibrate synchronously with the other, and without any correcting application whatever; and yet Mr. La Cour tells us that by this method he had incessantly, from morning till night, synchronism between Fredericia and Nyborg, and the managing director of the Danish Government Telegraph has given testimony to show that this synchronism worked perfectly accurate and reliable, and was easy to manage.

Any one acquainted with the subject must see that synchronism could not be obtained in this manner. The Franklin Institute Committee is in error in supposing that the words claimed to have been transmitted were caught by the receiving operator when the instruments happened to swing together in synchronism. They could not swing apart without stopping the fork and distributor at the receiving station, since the fork could not vibrate except by the impulses received over the line, and in order to receive them the instruments *must first be in synchronism*. The circuit tables of the distributors had 60 segments; 6 of these were used for the synchronous impulses, 6 were left disconnected, and 48 were set apart for telegraphy. To start the distributors, an impetus of velocity had to be imparted to the distributor by hand. This velocity must be higher than the normal rate of notation of the first distributor. As the velocity decreased, it was expected that by chance the trailing finger would touch the six segments corresponding in position to the six battery-connected segments at the distant station exactly at the same instant that the trailing finger touched them at the first station. Should this happen, these feeble impulses at the rate of 18 per second were depended upon to keep the fork at the receiving station in absolutely synchronous vibration, and the distributor in synchronous rotation. During an experience of nearly six years with vibrators and distributors I have made many experiments to determine how long two distributors could be made to run synchronously on corresponding segments, *with each vibrator making and breaking its own circuit automatically*, and having first been balanced synchronously by means of correcting devices used in my system. By throwing off the receiving correcting switches at each distributor the instruments run independently, and as soon as a variation takes place sufficient to deliver a correcting impulse in the segment, in advance or behind the corresponding segment. At the sending station, of course, the impulses usually delivered into the correcting devices will be heard on the operator's instrument, connected to the segment adjoining the corrector segment. The time of variation from one segment to another on a sextuplex machine, with 84 segments and a like number of earth segments between, making in all 186 divisions of the circle, over which the trailer makes three complete revolutions per second, equal to the one five-hundredth part of a second for each segment, has been all the way from a few seconds to about three minutes, the average being about 20 seconds. In practice a normal balance which will keep the distributors on corresponding segments for 15 seconds is all that is ever sought before turning on the correcting switches. Now, if it be admitted, for the sake of argument, that La Cour's apparatus worked in their dependent relation as well as if they had obtained their motive power from independent sources they must, in the nature of things, have gone out of synchronism every 15 or 20 seconds, and as soon as synchronism was lost the second fork could no longer vibrate, because it was cut off from its current. In the face of these indisputable facts, easy of demonstration, Mr. La Cour and his friends in Denmark claim that synchronism was perfect from morning till night for a period covering about 20 days. During this time about one hour's work was selected as an extraordinary test, with the results claimed—two circuits, not for an hour consecutively, but intermittently, averaging four and a-half words per minute each, or, combined, about one-fifth of the capacity afforded by the same wire in the hands of expert operators without La Cour's apparatus. But I maintain that even this performance was beyond the power of the system *if the instruments were left to themselves.*

Mr. La Cour had a plan for synchronising which he has not mentioned in his contributions to scientific literature, nor in his complaints against me; and it is to this plan that I invite the special attention of scientists. It consisted of a *turntable* operated by hand, with segments and connections corresponding to and connected with the circle of segments of his distributor over which the trailing arm swept. With this turntable it might be possible to follow recreant sychronism all around the circle for a short time, and perhaps keep the fork vibrating and catch a word on the wing. I have no means of knowing whether this turntable was the secret of the synchronism claimed between Nyborg and Fredericia. Certain it is, however, that it could not have been maintained by the more theoretical plan described by Mr. La Cour. It was by the turntable plan that Mr La Cour accomplished his so-called synchronism in America in 1881. He left the turntable behind him. I will not comment on Mr. La Cour's studied avoidance of any reference to this instrument, which played such an important part in his demonstrations. I leave the scientific world to contemplate the wonderful synchronism produced by him in 1880-81, and which the Danish officials so generously endorse as "perfect synchronism."

If Mr. La Cour will pardon the suggestion, I would advise him to repeat his Fredericia and Nyborg demonstration, unless synchronism on that plan has become a lost art. Its reproduction would throw much light on this question. If he succeeds without the turntable, then I will publicly recant all my doubtings. Until he gives another demonstration, however, I shall continue to dispute the correctness of his claims, and the statements of the Danish officials as well.

The "speculators" in America, to whom Mr. La Cour refers, and to whom he had given an option, several times renewed, were his own countrymen, which is the only excuse that can be found for their statement to La Cour that "the Americans whom we had engaged, and who were supposed to be such eminent men, are possessed of considerably less theoretical knowledge than an ordinary telegraph operator in Scandinavia." It is a pity that the inability of the eminent men of America to recognise synchronism in the results officially endorsed in Denmark should have brought down upon them such a severe criticism; but I think they could better afford to concede their invincible ignorance when compared with the ordinary telegraph operator of Scandinavia rather than put

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themselves on record as having obtained "perfect synchronism," whereby a multiplexed wire was reduced to one-fifth the efficiency of an ordinary single circuit, even if they had succeeded to this extent, which was not the case, Mr. La Cour having failed to provide them with a turntable, thereby giving the Scandinavians an unfair advantage. The American telegrapher needs no defence at my hands. He may not have as much theory as his Scandinavian brother; but he knows a practical telegraph system when he sees it, and it is well known that he can send more into and get more out of a telegraph wire than any other telegrapher in the world.

It seems, however, that the eminent Americans are not the only people that lacked the theoretical knowledge necessary to succeed with Mr. La Cour's apparatus. Eminent men of other countries have tried it. English, French, Germans, and Austrians have been well aware of the attempts at synchronism and the Fredericia-Nyborg demonstration, but none of them were ever able to bring about even these results. I was told by Mr. La Cour himself that he had given a half interest or more in his Austrian patents to a prominent engineer and inventor in the Austrian telegraph service, as an inducement for him to make it work and apply it to some form of telegraph. The engineer has been working at it for the past five or six years without success. The Germans purchased instruments of the La Cour type seven years ago, but have never been able to transmit one word by them. It may be that Mr. La Cour withheld the turntable, as he did from the "eminent Americans" with whom his representatives had to deal. The "speculators" before whom he demonstrated synchronism in America were evidently the kind of audience he wanted, as a turntable exploit showing the dexterity of Mr. La Cour in chasing synchronism around the circle of segments would have been more amusing than edifying to a body of electricians or telegraphists.

Mr. La Cour's patents had been allowed to lapse in every country in Europe, and had it not been for the confidence reposed in my efforts by a few American gentlemen who took up the enterprise after the Scandinavians had allowed their option to expire for the second or third time, the phonic wheel would have passed into obscurity, and its possible inventor would not now be so prominently before the public, claiming the fruits of my labour.

This, then, was the state of the art when Mr. Jones, acting for himself and others, bought Mr. La Cour's patents. Mr. La Cour must know that no American or other speculator of common intelligence, would pay a handsome sum for a telegraphic invention which, instead of being an advantage, would, according to the best showing up to that time (four words per minute by turntable), render a telegraph line worthless.

No; the patent was bought as a motor for my synchronous system, and, as such, it has been used ever since, and for this motor I have always given the inventor full credit.

Mr. La Cour had not invented his "improved synchronism" at that time. It was more than six months afterwards, Mr. La Cour says, "that a bargain was then arranged for my patent in the United States. This patent was only the patent for the phonic wheel, not for its synchronism." He had but one patent, and his "improved synchronism" was not yet invented. What, then, did Mr. Jones purchase? Simply what I required for a motor. There was no synchronism. Mr. La Cour says further, "but I undertook to inform Mr. Jones what more I had invented and possibly might invent with regard to this subject, so that he might patent in America. Mr. Jones, on the other hand, promised to send me particulars of any improvement which he might make, *so that I could patent them in Europe.*" From this it would appear that Mr. La Cour stood ready to take out patents in Europe in his own name for any improvements made in America, and because my patents were not communicated to him for this purpose he considers himself badly treated. If Mr. Jones made any such promise, he had no authority to speak for me, nor could he commit me to any such dishonest and illegal transaction.

Mr. La Cour's "improved synchronism," while a step in the right direction, and far in advance of the turntable system, was found to be impracticable then, as it is to-day, and attracted no notice here. Having received a liberal sum from the Americans for his phonic wheel, the patents for which were not worth keeping alive in Europe, and knowing that synchronism was being worked out in America, he sought to forestall us in Europe by an additional patent.

Mr. La Cour makes a baseless and misleading charge to the effect that he was lured into taking out an additional patent on his "old synchronism" in the United States in July, 1884, in the interest of Mr. Jones, so as to make it appear that his "old synchronism" was patented subsequent to the date of my patents of 1883. No one knows better than La Cour that the object of that patent was to secure better protection for his original patent in this country, and in which certain features were not fully set forth. My patents, issued nearly a year previous, all made reference to La Cour's phonic wheel.

In his second article (*Electrical Review*, October 7, 1887), Mr. La Cour gives a list of his discoveries as to how the rate of vibration of a tuning fork may be altered.

"1. By making the contacts stiffer or by approaching them to the tuning fork the number of oscillations is increased.

"2. By approaching the poles of the electro-magnet to the tuning fork the number of oscillations is reduced.

"3. By increasing the current which keeps the tuning fork in oscillation the number of oscillations is reduced.

"4. By increasing the temperature of the tuning fork the number of oscillations is reduced."

The first proposition is only partly correct. The reverse is equally true. It depends altogether where the magnet and the contacts are placed, and whether they push inwardly or outwardly. Where two contacts are used, one for each time and for running the motor and fork in separate circuits, I am strongly of the opinion that one leg of the fork may have a slightly different rate of oscillation from the other, and that the increase of pressure against one tine will affect the other, with a reverse tendency to the one directly affected. Certain it is that different amplitudes of oscillation may be produced. This will also slightly affect the synchronism, for I have found that a radical change in the strength of the motor current will affect its speed independent of the rate of the vibrator.

Regarding the second proposition, the reverse is also equally true. It depends altogether upon the *location of the magnets.* I found in 1882 that while a magnet placed outside of the tines of a vibrating fork would lower its rate of vibration. A magnet placed *within* the tines will *increase* the rate, and the stronger the current

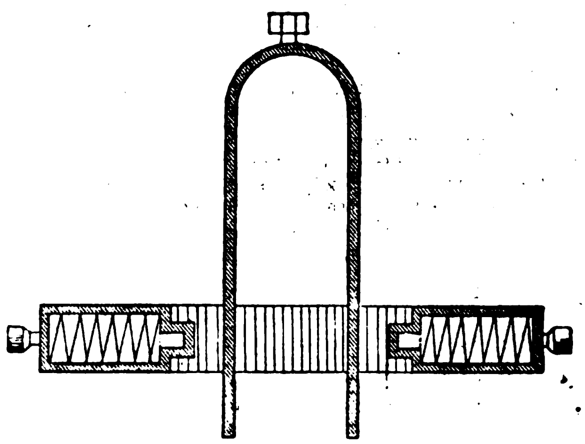
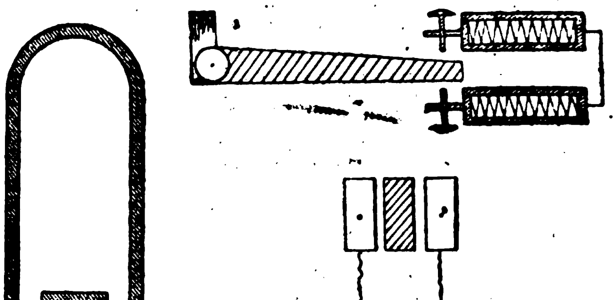


Fig. 1.

in the magnet the *higher* the rate. This also applies to the third proposition.



Figs. 2, 3, and 4.

As to the fourth, that "discovery" of Mr. La Cour's was known before he was born. Thus, without any disposition to upset Mr. La Cour's premises so far as they go it will be seen that the exact reverse of the results claimed by him are obtainable by the same identical means. In this connection I may state that a tuning fork vibrating under the influence of magnetism or in a magnetic field has a rate differing very much from its rate apart from this influence. The magnetic oscillation is not the normal rate. Tuning

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forks do not answer well as automatic interrupters for synchronous movements. I failed to obtain thoroughly reliable work until I substituted reeds in 1884-5.

The claim advanced by Mr. La Cour in his writings and patents that an increase of amplitude causes a decrease in the rate is only conditionally correct, and the opposite effect is quite as readily proven. It depends upon the means used to bring about the increased or decreased amplitude of oscillation. Strengthening the current of an *actuating* magnet outside of the fork will increase the range of oscillation and lower the rate. Strengthening the current of a magnet outside the fork and independent of its vibration will *decrease* the amplitude and *lower* the rate when the magnet poles are projected towards the sides of the fork or reed. If projected towards the edges of a reed an increase of the current decreases the amplitude and *increases* the rate of oscillation. These are but a few of the peculiarities attaching to the action of vibrators discovered by me by exhaustive experiment in striving for practical results during the past six years. Still they will be sufficient to show that Mr. La Cour's discoveries are insignificant when compared with what he left undiscovered, and which he does not seem to understand even now.

If, as he says, his discoveries were published in his pamphlet in 1878, why did he not make use of them for synchronism at that time instead of waiting for Mr. Cassanges in 1886? Why did he not use these discoveries himself in America in June, 1881, three years after their publication, instead of resorting to the use of a turntable or *manual* synchronism. He should not accuse me of taking advantage of a communication to Mr. Jones in the autumn of 1882, containing what had been published to the world in 1878. He says that his discovery that varying the strength of a magnet varied the rate of a tuning fork was the main thing, that the manner of its application is of minor importance. If this be true, then his communication to Mr. Jones in 1882 and his British patent of the same year could not have been of much moment, since the broad principle was published in 1878.

The plan for synchronising proposed by Mr. La Cour in his communication to Mr. Jones was tried by Mr. Calahan and myself without any satisfactory results whatever. It has been tried in Austria without any success, so far as I am able to learn. Mr. Cassanges' experiment, according

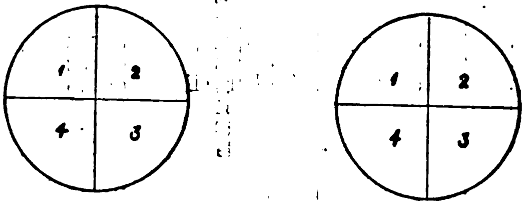

FIG. 5.

to the diagrams shown by that gentleman in a publication describing it, was *not* according to Mr. La Cour's plan. For Mr. Cassanges shows that instead of *breaking* the circuit when the armature of the polarised correcting relay moved from one stop to the other he undulated it according to my patent. If the difference is immaterial, why was my patent infringed? There is a very wide difference in this point alone. It is fully explained in my communication to the Franklin Institute:—"Reference to his description and drawings will show that the trailer H at Station 2 is expected to touch *two* contacts, *p p*, while the trailer at Station 1 is on one of the contacts, *o e*. And no matter which position the armature of the polarised relay is in, the fork and wheel *must be going either too fast or too slow*. They are not allowed to remain synchronous. Again, supposing the armature T of the polarised relay is in the position shown in the drawing, the fork is then vibrating too fast, a reverse current throws the armature over to its other stop to make it go slow, but while the armature is passing from the fast to the slow battery, the fork circuit being *entirely broken*, the rate of vibration of the fork is enormously increased, and the instruments driven away from even approximate synchronism. Therefore, when the distributor at Station 2 requires a retarding correction, it must first be accelerated far beyond the rate which called for retardation.

It must also be understood that the most delicate balance will not prevent the instruments from constant variation. If the change from the strong to the weaker battery is sufficient to *accelerate* the speed of the second instrument against its natural tendency to go slow at the time, this acceleration, being *constant*, will also be sufficient to cause the instrument to gain sufficiently in one revolution to entirely miss the segment for a retarding impulse on the next revolution, and *vice versâ*.

Assuming that a line, say, of fifty miles or upwards connects the two instruments, if a correcting impulse for slowing is needed, the trailer at Station 1 must be on battery segment *e* when the trailer at Station 2 is on the left hand contact *p*, then on account of retardation of the impulse in the line, the impulse will not arrive at Station 2 until the trailer at that station has passed off of the left-handed segment *p*, and no correction will be applied.

Again, even if it were admitted that all else worked as Mr. La Cour claims it will, it must be assumed that his correcting segments to which the batteries are connected are as broad as the other segments used for telegraph signals (for otherwise the correcting impulses would not charge the line sufficiently to be felt at the distant end). Then, this being the case, it follows that the trailer at Station 1 must be, say, half way on the battery segment before the line can be charged sufficiently to change the position of the armature of the polarised relay, and consequently the variation of the trailers would be from the middle of one segment to the middle of the other, or equal to two segments, for the spaces between the segments must be included, and each space must be equal to the width of each segment to prevent interference between the segments forming the circuits. Therefore the instruments would be out of synchronism two-thirds of the time. The charging point is indicated by the dots on the segments. Mr. La Cour makes no provision for static discharge, "tailing," or retardation of the current. The quality of all his corrections must be the same; a slight variation cannot be rectified, nor is the correction in any way proportioned to the discrepancy in synchronism. It is not necessary for me to remind your readers that synchronism at best is but a relative term; that it is all a question of degree. The Hughes, Meyer and Baudot systems are all synchronous within certain limits. Two trailers, touching corresponding sectors of these circles, might be called synchronous. But synchronism on segments one millimetre in width, in a circle five inches in diameter, with trailers revolving at the rate of three times per second, is quite a different thing.

Mr. La Cour might as well contend that there is no difference in principle between a make and break telephone and an undulating current telephone, and yet it cannot be denied that the former is of no use whatever. This particular feature constitutes but a very small part of the differences between Mr. La Cour's abortive attempts and my synchronism, covering nearly twenty patented inventions and rendering synchronism within the 1,000th part of a second a practical and constant achievement. Without this perfection multiplex telegraphy could not be accomplished.

The Cassanges experiment was made in 1886, with all my inventions before him. The reports of his experiment are made by *Mr. Cassanges himself*. His system is steno-telegraphy, one character representing a sentence, so that the number of words said to have been transmitted afford no guide as to the success or continuity of the sychronism. When Mr. La Cour told me in Berlin in 1886 that he had been witnessing Mr. Cassanges' work in Paris for two weeks, I asked him whether the three circuits claimed to have been operated were operated all in one direction or in opposite directions simultaneously. *He said he "did not know."* Synchronism, whereby three circuits are worked in one direction, using stenographic characters in the transmission of news matter, admitting of a wide range of guesswork, is at best but a slender pretext. Even this experiment involved a flagrant infringement of my patents. While in Berlin in the summer of 1886 I operated in a most successful manner for two months four circuits between Berlin and Hamburg, the circuits being worked all in one direction, or in opposite directions, or alternately in both, as the traffic demanded. Nearly all the traffic between these two cities was carried by my system during this time, and every message perfectly recorded in the Morse characters. Eight circuits for printing instruments were obtained over a similar circuit, and printers and Morse instruments were worked over the same lines at the same time. I also obtained four circuits over a sixty miles line of underground cable requiring synchronism by retarded currents, never dreamed of by Mr. La Cour.

Striving to prove that my system of reciprocal and alternating correction impulses is but an elaboration of his single impulse, Mr. La Cour draws this simile:—"If a man invents an ingenious lock and patents the same, another person has no right to patent a safe upon which he attaches two of these locks because he asserts the former inventor has only patented one lock and the greater security is obtained by two locks." But if the first man's lock is inoperative and worthless the man who invents a safe to fit and make it operative and valuable is entitled to the credit. I would not think much of a safe lock that required the inventor to hold it on the safe in order to keep the door shut. This is exactly what Mr. La Cour did with his synchronous (?) *turntable*, synchronised by turning the segments back and forth to keep up with the trailing finger.

Mr. La Cour's performance in the field of synchronism is sadly disproportionate to his claims. He appears to be another one of those inventors who waits patiently for somebody to make him famous.—Yours, &c., PATRICK B. DELANY.

84, Broad-street, New York, Dec. 24, 1887.

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ON THE HEATING EFFECTS OF ELECTRIC CURRENTS.—No. III.*

pp 386, 411

BY W. H. PREECE, F.R.S.

I have taken a great deal of pains to verify the dimensions of the currents as detailed in my Paper read on December 22, 1887, required to fuse different wires in such thicknesses that the law

$$C = a\,d^{3/2}$$

is strictly followed, and I submit the following as the final values of the constant "a" for the different metals:—

	Inches.	Centimetres.	Millimetres.
Copper	10,244	2,530	80·0
Aluminium	7,585	1,873	59·2
Platinum	5,172	1,277	40·4
German Silver	5,230	1,292	40·8
Platinoid	4,750	1,173	37·1
Iron	3,148	777·4	24·6
Tin	1,642	405·5	12·8
Alloy (lead and tin 2 to 1)	1,318	325·5	10·3
Lead	1,379	340·6	10·8

With these constants I have calculated the two following tables, which I hope will be found of some use and value :—

TABLE *showing the current in amperes required to fuse wires of various sizes and materials.*

$$C = a\,d^{3/2}.$$

No. S.W.G.	Diameter. Inches.	$d^{3/2}$.	Copper. a=10,244.	Aluminium. a=7,585.	Platinum. a=5,172.	Ger. Silver. a=5,230.	Platinoid. a=4,750.	Iron. a=3,148.	Tin. a=1,642.	Tin-lead alloy. a=1,318.	Lead. a=1,379.
14	0·080	0·022627	231·8	171·6	117·0	118·3	107·5	71·22	37·15	29·82	31·20
16	0·064	0·016191	165·8	122·8	83·73	84·68	76·90	50·96	26·58	21·34	22·32
18	0·048	0·010516	107·7	79·75	54·37	54·99	49·95	33·10	17·27	13·86	14·50
20	0·036	0·006831	69·97	51·81	35·33	35·72	32·44	21·50	11·22	9·002	9·419
22	0·028	0·004685	48·00	35·53	24·23	24·50	22·25	14·75	7·692	6·175	6·461
24	0·022	0·003263	33·43	24·75	16·88	17·06	15·50	10·27	5·357	4·300	4·499
26	0·018	0·002415	24·74	18·32	12·49	12·63	11·47	7·602	3·965	3·183	3·330
28	0·0148	0·001801	18·44	13·66	9·311	9·416	8·552	5·667	2·965	2·373	2·483
30	0·0124	0·001381	14·15	10·47	7·142	7·222	6·559	4·347	2·267	1·820	1·904
32	0·0108	0·001122	11·50	8·512	5·805	5·870	5·330	3·533	1·843	1·479	1·548

TABLE *giving the diameters of wires of various materials which will be fused by a current of given strength.*

$$d = \left(\frac{C}{a}\right)^{2/3}.$$

Current in amperes.	Diameter in inches.								
	Copper. a=10,244.	Aluminium. a=7,585.	Platinum. a=5,172.	Ger. Silver. a=5,230.	Platinoid. a=4,750.	Iron. a=3,148.	Tin. a=1,642.	Tin-lead alloy. a=1,318.	Lead. a=1,379.
1	0·0021	0·0026	0·0033	0·0033	0·0035	0·0047	0·0072	0·0083	0·0081
2	0·0034	0·0041	0·0053	0·0053	0·0056	0·0074	0·0113	0·0132	0·0128
3	0·0044	0·0054	0·0070	0·0069	0·0074	0·0097	0·0149	0·0173	0·0168
4	0·0053	0·0065	0·0084	0·0084	0·0089	0·0117	0·0181	0·0210	0·0203
5	0·0062	0·0076	0·0098	0·0097	0·0104	0·0136	0·0210	0·0243	0·0236
10	0·0098	0·0120	0·0155	0·0154	0·0164	0·0216	0·0334	0·0386	0·0375
15	0·0129	0·0158	0·0203	0·0202	0·0215	0·0283	0·0437	0·0506	0·0491
20	0·0156	0·0191	0·0246	0·0245	0·0261	0·0343	0·0529	0·0613	0·0595
25	0·0181	0·0222	0·0286	0·0284	0·0303	0·0398	0·0614	0·0711	0·0690
30	0·0205	0·0250	0·0323	0·0320	0·0342	0·0450	0·0694	0·0803	0·0779
35	0·0227	0·0277	0·0358	0·0356	0·0379	0·0498	0·0769	0·0890	0·0864
40	0·0248	0·0303	0·0391	0·0388	0·0414	0·0545	0·0840	0·0973	0·0944
45	0·0268	0·0328	0·0423	0·0420	0·0448	0·0589	0·0909	0·1052	0·1021
50	0·0288	0·0352	0·0454	0·0450	0·0480	0·0632	0·0975	0·1129	0·1095
60	0·0325	0·0397	0·0513	0·0509	0·0542	0·0714	0·1101	0·1275	0·1237
70	0·0360	0·0440	0·0568	0·0564	0·0601	0·0791	0·1220	0·1413	0·1371
80	0·0394	0·0481	0·0621	0·0616	0·0657	0·0864	0·1334	0·1544	0·1499
90	0·0426	0·0520	0·0672	0·0667	0·0711	0·0935	0·1443	0·1671	0·1621
100	0·0457	0·0558	0·0720	0·0715	0·0762	0·1003	0·1548	0·1792	0·1739
120	0·0516	0·0630	0·0814	0·0808	0·0861	0·1133	0·1748	0·2024	0·1964
140	0·0572	0·0698	0·0902	0·0895	0·0954	0·1255	0·1937	0·2243	0·2176
160	0·0625	0·0763	0·0986	0·0978	0·1043	0·1372	0·2118	0·2452	0·2379
180	0·0676	0·0826	0·1066	0·1058	0·1128	0·1484	0·2291	0·2652	0·2573
200	0·0725	0·0886	0·1144	0·1135	0·1210	0·1592	0·2457	0·2845	0·2760
225	0·0784	0·0958	0·1237	0·1228	0·1309	0·1722	0·2658	0·3077	0·2986
250	0·0841	0·1028	0·1327	0·1317	0·1404	0·1848	0·2851	0·3301	0·3203
275	0·0897	0·1095	0·1414	0·1404	0·1497	0·1969	0·3038	0·3518	0·3413
300	0·0950	0·1161	0·1498	1·1487	0·1586	0·2086	0·3220	0·3728	0·3617

* Paper read before the Royal Society, Thursday, April 19th, 1888.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April 14th*, 1888.

In this country, as in England, at the present time, the subject of insurance rates, fire-office rules, &c., occupies to no small degree the thoughts of electric lighting men. In New England the general dissatisfaction at the existing state of affairs has led to the adoption of a plan which promises to introduce marked reforms. An Electric Exchange has now been organised in Boston for the object of issuing licenses to all who may be engaged in the work of electric light installation, or in wiring and general construction. The active membership in this exchange is limited to those who are actually employed in the electric lighting business in the New England States. The exchange is to have meetings four times a year, and is already organising for work, and it is to be hoped that its Board of Referees will serve as a medium of communication between members of the exchange and the various insurance authorities. It will be seen that here is the outline of a plan which might be very usefully developed all over the country, and which in its

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operation would do much to raise the standard of electric light work. In the city of New York the condition of affairs is said to be satisfactory, and the enforcement of the rules laid down here has brought the loss from electric light fires very far below that from gas. But outside of the city a laxer state of affairs, it is to be feared, exists, and there seems no reason why the good results which are attained in the city should not be realised all through the State. It has been suggested that local or State bodies, in conjunction with the National Electric Light Association, might enforce a universal standard for this class of work, and thus, while preventing cheap work and reducing the amount of unholy competition, secure in the long run a greater adoption of the electric light, and generally lower rates of insurance. It may be pointed out that, as the result of the enforcement of its rules and regulations, the New England Insurance Exchange has now been able to announce a material reduction wherever the electric light is used. This is significant of other things that may be looked for from the co-operation of the insurance and electric light interests.

In my last letter reference was made to the case of Englishmen who come out here in the hope of securing positions as electricians, and who are very often disappointed in their quest. I hear of a case this week which gives point to the warning. The young fellow in question had secured a position with small salary with one of the local companies; but on certain representations was induced to make a trip from here to Montana, which is nearly equal, I believe, to the distance from England to America. When he got to his destination he found that things were not as had been stated, and that he had made a long, wearisome, and expensive journey for nothing. Of course, this threw him on his back, and as in the new Western settlements there is not a very large variety of occupations, he was only too glad to find employment as a miner. The experience in this case was a hard one, but fortunately did not have any bad effect, the man being made of sterling stuff. Still, I do not think that he received his electrical training, or made the voyage to this country, for the purpose of spending twelve hours a day as a pioneer member of the pickaxe and shovel brigade. He is now, I believe, back in New York, a good deal wiser, even if not much sadder, and it will be a long time before he is again induced to make the tour across the continent.

I would not be understood, however, to intimate that there are no opportunities here. The chances are many, and new ones crop up every day; I suppose it is simply a question of being "in the swim." For instance, not long since I predicted in this letter that with the coming of spring we would see a great revival of work in the field of electric railways. Taking up the *Electrical World* this week I find nearly forty items referring to new electric railway projects, the roads being situated in New York, Pennsylvania, Nebraska, Tennessee, Massachusetts, Ohio, Arkansas, New Jersey, Missouri, Indiana, Virginia and Illinois. A great many of these roads are already at work, either building or making the necessary changes, and it must be evident to anyone who is acquainted with the facts, that here alone is a vast amount of work to be done during the coming year. Many of these new roads will be 4 or 5 miles long, and they will illustrate all the various methods and systems in use, though the majority of them will have overhead conductors. Some idea of the interest taken in the matter may be gathered from the fact that the great Pullman Company is about to construct an electric street railway 5 or 6 miles long, double track, at Pullman, Illinois. This road will be first-class in every respect, and the mere fact of its construction by such a company indicates the way the wind is blowing.

It will be remembered that mention was made last week of the argument presented by the Edison Company before the United States Circuit Court here in regard to the limitation that is put upon American patents by foreign patents or the expiration of their "terms." The general feeling of discontent at the situation is now voiced in a Bill, which has been prepared by Mr. Arthur Steuart, the general counsel of the National Electric Light Association, and presented to Congress on behalf of that body. This Bill is intended to remove the doubts that exist on this subject, and to release American patentees from all the anxieties that have attended their movements in the endeavour to secure protection abroad as well as at home. This Bill expressly provides that "No patent granted for an invention which had prior to the grant of such patent been first patented in a foreign country, and which has not expired at the date of the passage of this Act, shall be declared to be invalid by reason of its being so limited on its face or in its grant as to expire at the same time with the foreign patent, or if there be more than one at the same time with the one having the shortest term." The Association also is urging two other Bills, one of which establishes a court of patent appeals, with a chief justice and four associates, and the other of which prolongs the term of the commissioner of patents, and increases the emoluments of himself and his associates. All these measures are regarded as being aimed in the right direction, and will enlist very general, if not unanimous, support.

By an order of the Court of Common Pleas, at Philadelphia, the celebrated Keely motor is to be inspected this month, and the results of the investigation are awaited with a great deal of interest, although it is probable they will not be made public immediately. The action of the Court in this remarkable case was brought about by a suit in which the plaintiff claims that Keely, nineteen years ago, assigned to him the patents of the wonderful motor, and the inspection now to be made by experts is for the purpose of determining whether or not the apparatus which Keely has in course of construction is the same as that alleged to have been assigned. One of the experts named by the Court is Prof. W. D. Marks, who is well known to a great many electricians from his prominent connection with the Philadelphia Electrical Exhibition in 1884, and his participation in the dynamo tests made at that time. Prof. Marks now occupies the Chair of Dynamical Engineering at the University of Pennsylvania, and is engaged also as an expert in connection with the Edison Company of Philadelphia. With him are associated men of like reputation and calibre.

From time to time we have had schemes for utilising Niagara, and some of the most recent of these I have already brought to your attention. That of the Niagara River Hydraulic Tunnel Power and Sewer Company is just now attracting public attention, and promises to be no mean enterprise. The idea of the company is to utilise some of the power of the Niagara river by boring a tunnel from the water level below the Falls, about 200ft. under the high bank of the river, extending through the rock to the upper Niagara river at a point one mile above the Falls, and at which a head of 120ft. is obtained. This tunnel is then to run parallel with the shore of the river one and a-half mile, at an average depth of 100ft. below the surface of the earth, and at a distance of about 400ft. from the navigable water of the river, with which it is to be connected by means of conduits or lateral tunnels. The point is that the power is to be obtained from the conduits, and not from the tunnel itself or from the Falls. These conduits are to have wells, in which are placed the turbines. The estimated cost of construction is £600,000, and the assertion is made that enough patronage has already been obtained to pay a fair dividend on that sum. The city of Buffalo is ready to pay £20,000 a year for power for electric lighting, and it is said that an electric smelting company is ready for the delivery of 20,000 horse-power. The company has secured land enough along the river to make room, with ample streets and dockage, for 238 mills of 500 horse-power each, or 119,000 horse-power in all, and by means of electric motors the power can, of course, be distributed over a much wider area. It is pointed out that one recommendation and beauty of the plan is that there will be no soot or smoke from the various factories, that the volume of water will not be materially lessened by the construction of the tunnel, and that the facilities for transit in all directions are admirable. The project is grandiose and typically American, and some of your readers may doubt the possibility of its execution. My own opinion is, however, that something of this kind will be done to utilise the greatest waste of water power in the world. The

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success achieved at such places as Rochester in this State has done much to direct the serious attention of electricians to this subject, and whenever Niagara is utilised to any great extent it may be confidently assumed that electricity will play a leading *rôle*.

A very interesting meeting of the American Institute of Electrical Engineers was held this week, at which a Paper was read by Mr. John W. Howell, the electrician of the Edison Lamp Company, on the subject of the maximum efficiency of incandescent lamps. In using the term Mr. Howell did not mean by "maximum efficiency" the highest efficiency at which a lamp can be operated, but the efficiency at which it will give the best results considered as an element in a plant, or, in other words, the efficiency at which the cost of operating it is the minimum. Mr. Howell then submitted a number of curves in which with lamps at various costs, life, and current cost, it was shown that this efficiency was reached in every case when the lamps cost about 15 per cent. of the total expense of operating the plan. In this way, Mr. Howell established a very simple law for determining whether or not lamps are being operated at a maximum efficiency. If the lamp bills are more than 15 per cent. of the total operating expenses the lamps are being burned above their maximum efficiency. If, on the other hand, the bills are less than 15 per cent., the lamps are being burned below their maximum efficiency, and higher efficiency lamps would reduce the cost of operating the plant. From this it is deduced, for example, that where fuel is high-priced, or where other causes operate to make the cost of delivering the current high, it is imperative for economical reasons to use lamps of the maximum efficiency, the curves showing that where the cost of current is high the use of lamps a little above or below the maximum makes a very marked increase in the total operating expenses. Another important deduction was that if, for example, the lamp bills are only 10 per cent. of the total expenses, increasing the efficiency of the lamps by increasing their candle-power does not cut down the total cost; but in order to reach that desirable end the lamps must be replaced by others of the same candle power, but of higher efficiency. If, on the other hand, the efficiency of the lamps is increased by raising their candle-power, the cost of operating the plant per unit of light produced is cut down; but the total cost is increased. This law enables any one, says Mr. Howell, to determine, in the operation of an incandescent plant, whether he is using the right lamps or not. The paper, in its entirety, is a valuable contribution to the practical development of incandescent lighting, and was well received. Mr. Howell stated, in the course of the evening, that the work done on the curves extended over four or five years, involved laborious tests with hundreds and hundreds of lamps, and cost at least $10,000. The question raised in the discussion as to the effects of direct and alternating currents on the life of incandescent lamps elicited no evidence to show that the one current was more harmful or beneficial than the other. The statement was made that the uniformity of running with lamps on storage batteries had not been by any means so great as was expected, and that, practically, better results had been obtained as to steadiness of potential with currents direct from the dynamo, which gave a longer life to the lamps.

NOTES FROM PARIS.

(FROM OUR OWN CORRESPONDENT.)

PARIS, 24*th April*, 1888.

I have no change to report in electric lighting affairs. No proposition has yet been made to the city by any company, and it now seems probable that the Conseil Municipal (which assembled yesterday for a period of one month) will undertake a revision of the Cahier des Charges. In that case we may hope for such an amendment of its provisions as will render the scheme possible to undertakers for the distribution of electric light to the public. Private plants are still extending, especially in coffee houses and restaurants, in view of the approaching summer season. There was a large display of the electric light at the Military Carrousel given at the Palais de l'Industrie, Champs Elysées, on the 18th inst., for the benefit of the Société Française de Secours aux Blessés Militaires. The central part of the Palais, which occupies a space of about 600 feet long, 150 feet wide, and 120 feet high, was lighted with 60 Jablochkoff candles, 5 Gramme arc lamps of 60 amperes, 12 do. of 25 amperes, and 20 Thomson-Houston arc lights of 10 amperes. The total light amounted to about 200,000 candle-power, and the room was as well illuminated as by daylight. The *Carrousel*, given by the best cavalry squadrons from the military schools of Saumur, Saint Cyr, and Fontainebleau, was of the most brilliant effect, and attended by more than 10,000 people. M. Carnot, the President of the Republic, all the Ministers, Ambassadors, generals, &c., were present, and highly praised the electric lighting. Although the plant, under the management of M. Georges Fournier, was erected within four days, it worked most steadily and without the least trouble from 8 p.m. up to two o'clock in the morning.

Messrs. Philippart Brothers, owners of the French Faure-Sellon-Volckmar patents for the fabrication of accumulators, are instituting proceedings against MM. Gadot, Garriant and other manufacturers of accumulators. The opinions of electricians as regards the result of the suits differ widely, and some time must elapse before the final decision of the law courts is given.

CORRESPONDENCE.

TELEPHONE SYSTEMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest your articles on "A Proposed Telephone System," by Mr. Walker Moseley, and although they contain valuable information, there are several points which appear to me to be open to adverse criticism.

In the first place, he describes a system of exchanges consisting of a principal one and forty other small ones. This appears to me to be a distinctly retrograde step, as it causes a multiplication of the number of exchanges, and one which is contrary to all experience. The fact that at the present time the companies in both New York and London are making every effort to cut down the number of their exchanges by centralisation would, I should think, show this to be the case.

The substance which he proposes for the insulation of wires, consisting of horsehair and resin, would appear to me to be much too brittle for this purpose; in fact, Mr. Moseley owns that it would not stand rough usage. I am inclined to doubt whether the ordinary handling in running such a wire would not break away the insulation sufficiently to admit moisture. That covering such an insulated wire with molten metal will not injure the insulating material is beyond my comprehension, and I should like to know whether this method has ever been tried even on a small scale.

His multiple switch-board is certainly exceedingly ingenious and looks well on paper, but in practice I feel that the first duty of the man who was appointed to try to keep it in working order would be to insure his life, for I am certain that it would be of but short duration. We will go into a few details about this switch-board. One of the principal desiderata of a multiple switch-board, and one which Mr. Moseley does not point out, is this—the dimensions of each section of the board should be such that an operator, when standing still, or preferably when sitting, can put a connecting plug into any plughole on that section. To do this the greatest length which can be allowed for a section is six feet, and into this length 96 plug-holes of the dimensions shown in Mr. Moseley's drawings could be fitted. By reducing the front plates of these slightly, no doubt 100 might be fitted in the six feet. Consequently, in an exchange of 3,000 subscribers there would be 30 rows of 100 plug-holes each, one row above the other in each section. Now let us try to imagine what the back of

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such a board would be like. There would be 30 layers each of 100 stretched wires and chains; allowing ¾in. from wire to wire, as shown in the drawings, they will occupy a space of 6ft. 3in. by 1ft. 10½in.—that is to say, that if you stood at the back of the board, the wire nearest the board would be 6ft. 3in. away from you, and it will be well protected from any interfering persons by 99 other wires. But suppose one of these wires breaks, or even if it stretches, how is it to be got at in order that it may be repaired? And if we consider what the length of each wire in an exchange of 3,000 subscribers would be, and also the number of joints to the chains in each, it will not appear that stretching and breaking are at all unlikely events. Two hundred subscribers are generally considered as the greatest number which can be properly attended to on each section of the system of multiple switch-boards at present in use. This would give 15 sections in a 3,000 line exchange, and each section being, as I have pointed out, 6ft. long, the length of each of the wires will be 90ft., allowing no space between each section, which, however, would be necessary in practice; and the number of joints in each wire will be 32. Stretching of the wires would be easily caused by an operator pressing a plug into a plug-hole when the subscriber's line, of which that was the plug-hole, was engaged on another section; and if a wire were to stretch more than 1½in., it would prevent the indicator circuit being broken at the spring contact, shown in Fig. 12 of Mr. Moseley's drawing, when the subscriber was plugged through to another subscriber, and the result would be that their lines would be short circuited through the indicator. Another fault I should expect to be by no means unfrequent, would be the failure of this spring to make contact properly; this would happen if the wire became shortened by bending or by the chains getting twisted, both matters of possible occurrence, the result being that the subscriber would find his line insulated. There is one other matter of detail which constitutes the chief labour of fitting up, and one of the principal difficulties in the present form of multiple boards, to which Mr. Moseley does not appear to have directed his attention: it is the running of the wires for the electrical circuits. Although this appears very simple in his diagram, where the circuits of only two subscribers' lines are shown, when we remember that there will be two wires leading to and two away from each plug-hole and its back spring, making in the 3,000 line exchange 6,000 wires to and 6,000 from each section, it will easily be seen that this is a matter requiring special provision, especially with wires insulated by Mr. Moseley's method.

Finally, there is one element, viz., that of cost, which I certainly should have thought that Mr. Moseley had left out of his calculations altogether had he not stated that he will submit an estimate of the total cost of his scheme. Two appliances in his system strike me as being particularly costly, and these are his insulated copper-sheathed wire and his multiple switch-board. I shall look forward to the estimates for these with particular interest.—Yours, &c.,

London, 18th April, 1888. F. B. O. HAWES.

ALTERNATING-CURRENT TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: "An Electrical Engineer's" letter in last week's issue shows that he has not quite understood "all that has appeared in the electrical papers (including Mr. Kapp's last Paper)." If he would give the current he wishes in his secondary circuit, the size and construction of his transformer, and the number of alternations per minute he intends to use, one could answer some of his questions, since the back E.M.F. depends on all these points. As some indication of the way in which the primary current varies with that in the secondary, I may give the following figures:—In a two horse-power transformer, of the latest type, intended for 185 volts at primary and 100 at secondary, the resistance of the primary coil = ·145 ohm, that of the secondary ·042 ohm. With open circuit in the secondary the primary current was 0·8 ampere, with 15 amperes in the secondary it was 8·3, and with 30 amperes in the secondary (twice the ordinary working current) it was 16 amperes.

With regard to the advantage of the closed magnetic circuit, it is, I should think, more a question of power for a given size and cost than of efficiency. The E.M.F. that can be put on to a transformer is proportional, *cæteris paribus*, to its magnetic resistance; if instead of iron half the magnetic circuit is in air, which has a permeability only about $\frac{1}{100}$th that of iron, it is easily seen that the power of the machine is very greatly reduced.—Yours, &c.,

A STUDENT SOC. T. E. AND E.

TO THE EDITOR OF THE ELECTRICIAN

SIR: I quite agree with "Electrical Engineer's" letter in your issue of the 20th inst. A short time ago I had occasion to design an alternate-current transformer, and only then did I find the gaps which did not appear on a mere perusal of Kapp's and Dr. Fleming's Papers. Certainly Mr. Kapp's Papers on "Induction Coils Graphically Treated" go a good way towards the production of a practical instrument, but after a deal of labour one finds some formula in which two or three constants appear and no description of the right method of obtaining them. To students of the subject as it stands it now presents many difficulties, not so much electrically as mathematically. "Electrical Engineer" seems to be in much the same predicament as myself; he has gone a little way into the subject, and then meets with difficulties right and left. He speaks about the resistance which the primary coil of an A.T. must have to allow a current C to pass. If I understand aright, impedance = $\sqrt{R^2 + (2\pi n L)^2}$, so that if we know the self-induction and the number of alternations it is not such a difficult matter to calculate the current produced by a given E.M.F.

So far as my reading has gone I understand inductance = $2\pi n L$ and impedance = (ohmic res.^{2} + inductance^2) to the power ½. I think "Electrical Engineer" is down rather hard on the secondary battery, for I have a few cells for private laboratory work, and since I got them two and a-quarter years ago I have only spent one shilling on them, and that was to burn on a broken lead lug. They are discharged at varying rates, and sometimes kept running at treble the authorised discharge, and they have never given any trouble. I send them in a barrow to be charged, and with the knocking about they get I never expected to find them last any time; but there are no signs of decay at all now. There are one or two points students, I think, are generally at sea about. These are—What is the "hysteresis coefficient" of a mass of iron? What is the relation between lag of current and impressed E.M.F. and self-induction? and, last, Has an electro-magnet more or less magnetic lag with its armature off or on. I intend to perform the experiments "Electrical Engineer" spoke of when I have time, and shall give any results worth noting for his benefit. I find a commutated battery current makes a splendid alternate current.—Yours, &c., A STUDENT.

SELF-INDUCTION

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I do not know whether the report of Mr. Sumpner's Paper on the "Variation of Induction Coefficients" is intended as a full report, but there is one point in it I entirely fail to understand, viz., where he is reported to say that increase of self-induction may under certain conditions quicken the discharge of a condenser. Probably a very few words from him will suffice to explain and justify the statement, which, as it stands, is obscure.

By the way, I may as well say that I have never asserted or supposed it possible that the self-induction of an iron conductor is less than that of a copper one the same size. Its "time-constant" may be less, but that is another matter.—Yours, &c.,

OLIVER J. LODGE.

THE ROYAL VICTORIA HALL AND THE LATE MR. SAMUEL MORLEY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I ask a little of your valuable space for calling attention to a proposed memorial to one whose death was a

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national loss, the late Mr. Samuel Morley? So deeply was he impressed with the dangers arising from the extremes of wealth and poverty, and the dreary lives led by the very poor, that he often spoke of society as existing on a volcano, and spared neither labour nor money to lessen the evils he deplored. Among his many useful works none was nearer to his heart than the Royal Victoria Hall, which has for its object to brighten the lives of the poor by providing healthy recreation (apart from temptations to drink) and opportunities of instruction for those who desire them. It has been carried on under many difficulties for more than seven years. Once a gift of £1,000 from Mr. Morley (towards buying the remainder of the lease) saved it in a crisis, and from that time he regularly took the chair at the committee meetings. It has occurred to those who worked with him there that there could be no more fitting memorial of his unselfish life, none more in accordance with his wishes, than to establish this work on a permanent basis. During his lifetime he caused inquiries to be made as to the possibility of buying the freehold; but the then owner refused to sell, and there appeared no prospect for the future but that the hall should relapse at the end of the ten years that the lease had still to run into the state from which the present trustees rescued it. What that state was we may learn from the pages of "Alton Locke," or from the reports of any of the police, who used often to take thirty or forty from the old theatre to the lock-up on public holidays. But an opportunity now occurs of making a return to the old horrors impossible. The ground landlord is willing to sell the freehold, and the Trustees' Committee propose to raise a memorial fund to buy it. If they succeed they have reason to think that the Charity Commissioners will take it over as part of the scheme for the proposed People's Palaces for South London. In that case there would be no more appeals to the public on its behalf; its future would be provided for, and Mr. Morley's name associated for ever with the work he did not live to finish. But the proposal is for the Commissioners to meet the public with an endowment *after* the freehold has been bought; and for this £17,000 must be raised, and raised before September, unless a deposit of £500 (already paid) is to be forfeited. The value of the freehold, we are told, is much more than this. The landlord has abated several thousands in consideration of the public utility of the object, and £4,000 is allowed for the present value of the lease, which is freely given by the trustees and committee. The £17,000 covers the remainder of the price, law expenses, &c. Towards this individuals on the committee have promised £3,500.

I will not trespass on your space with details of the entertainments, concerts, lectures, technical and other classes, working men's clubs, &c., all flourishing at the hall. Let those who wish to know come and see. The popularity of the place is shown by the fact that £1,825 was taken in nine months for admission at the doors, chiefly in sums of from a penny to threepence. I will only add that this work fitly represents Mr. Morley's generous sympathy, inasmuch as it takes no account of differences of creed or party, and that all who wish to help in perpetuating the name of a good man in the way he would have chosen are invited to communicate with Miss Emma Cons, at the Royal Victoria Hall, Waterloo-road, S.E.—Yours, &c., LUCY C. F. CAVENDISH.

4, Upper Brook-street, W., 21st April, 1888.

[*Owing to the length of the Legal Intelligence in this issue, we are compelled to leave over several Letters to the Editor.*]

COMPANIES' MEETINGS.

Eastern Extension, Australasia and China Telegraph Company (Limited).

The twenty-ninth ordinary general meeting of this Company was held on Wednesday, at Winchester House, 50, Old Broad-street, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN stated that the gross receipts for the half year ended the 31st December last had been £232,660, being an increase, as compared with those for the same period of 1886, of £15,704; and the working expenses had been £69,570, or £10,496 less, mainly due to the cost of repairs to cables being lighter during the past half year than in 1886. The net revenue had shown an increase of £26,819, having amounted to £117,889 for the half year. For the whole year the gross receipts had been £451,861, being an increase over those of 1886 of £10,062; and the working expenses had been £145,812, being a decrease of £16,029, as compared with those for the year 1886. An interim dividend of 1¼ per cent. had been paid for the half year, and it was proposed to pay another of like amount on the following day (Thursday), making, with the interim dividends for the first half year, a total dividend of 5 per cent. It was also proposed to distribute a bonus of 3s. per share, which would make a total payment of 6½ per cent. for the past year, against 6 per cent. for the previous year. The balance of £53,051 had been carried to the general reserve fund, which now stood at £620,095. The net result of the past year's working was that the reserve fund had been increased by £50,000; the further partial renewals of the Singapore-Saigon and Penang-Rangoon cables had been paid for out of revenue, and 6½ per cent. would be distributed amongst the shareholders. Further drawings of the Company's Five per Cent. Debentures had taken place since the close of the half year, which, when paid off, would reduce the capitals outstanding as follows: Five per Cent. 1880 issue, £24,400, and Five per Cent. Australian Government Subsidy Debentures, £446,100. The completion of the renewal of Singapore-Saigon section with brass-ribboned cable had been carried out since the close of the half year. During the current year they proposed effecting some important alterations in the Madras-Penang cable, and in the Java-Australian cables. He regretted to state that they had not been successful in their negotiations with the New Zealand Government for a renewal of the subsidy, and they had, therefore, been obliged to increase the tariff over the New Zealand cable. They had thus been enabled nearly to recoup themselves for the loss of the subsidy. With reference to what had been said about a threatened Pacific cable, soundings had been ordered to be taken—a work which would occupy three years, during which period, at all events, the scheme would be in abeyance. Should the matter then arise again, they hoped the position of the Company would be so strong as to prevent the competing cable from being laid or, at least, to render its opposition devoid of annoyance or inconvenience to the Company. The Colony of West Australia was now desirous of having direct communication with the mother country; and if this desire could be acceded to in a manner which would be advantageous to the Colony and to the Company, the Directors would not lose sight of the matter. Referring to the negotiations with the Chinese Government, he stated that the agreement which had been arrived at still awaited ratification; but they themselves had no desire to hurry on the matter, for as the thing stood they retained money in their own exchequer instead of paying it away to the Chinese, who, they were quite sure, would soon see the advantage to themselves of ratifying the agreement. Since their last meeting they had completed an arrangement with the Netherlands-Indian Government for a cable of 462 miles, between Java, Baly, and Macassar, which would be paid for by that Government, and which would be a feeder to the Company's system. After referring with regret to the loss which they had sustained in the death of Sir Wm. M'Arthur, who had been connected with the Company since its formation, the Chairman concluded by moving a resolution for the adoption of the report and accounts, and the declaration of the dividend and bonus as recommended.

The Marquis of TWEEDDALE seconded the motion, which was unanimously adopted; and subsequently resolutions were unanimously passed re-electing Mr. John Denison Pender and the Marquis of Tweeddale to their seats at the Board, and reappointing the auditors, Mr. Henry Dever and Messrs. Quilter, Welton and Co.

A vote of thanks to the Chairman and Directors brought the proceedings to a close.

[We shall publish a full report of this meeting in our next issue.]

Reuter's Telegram Company (Limited).

The twenty-fourth ordinary general meeting of the shareholders was held on Wednesday, at the offices of the Company, 24, Old Jewry, Colonel James Holland, the Chairman of the Company, presiding.

The notice calling the meeting was read by Mr. F. J. GRIFFITHS, the secretary. The report and accounts were taken as read.

The CHAIRMAN said: Gentlemen, the general features of the accounts are an increase in the revenue, but a larger augmentation of expenditure, the former being £1,300 more and the latter £3,400 larger, as compared with 1886; hence the diminished dividend. The past year, though not marked by wars, yet had several prolonged periods of excitement, entailing considerable outlay, which was not compensated for by extra subscriptions, as would have been the case in the event of actual war. The totals of the balance-sheet and profit and loss account do not materially differ from the last. The sundry creditors and sundry debtors both show an increase, due to the larger transactions of the year. These have run off in the normal way, with one or two exceptions, which, however, do not involve a large amount. The reserve fund has been increased to nearly £12,000. Adverting to a question put at the last meeting the Directors think that on every favourable opportunity this fund should be continuously increased until it reaches a sum more nearly approximating to the amount of goodwill. Any writing down of the goodwill itself would appear as though the Board considered it had depreciated, whereas they hold quite a contrary opinion. The reserve fund not only serves for equalising dividends, but also gives stability to the Company. It is not deemed advisable, therefore, to fix any limit to its augmentation. In these days of competition the Company must have a good backbone to be able to meet all adverse contingencies. One such has, indeed, presented itself this

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year. A section of the Australasian press has ceased to take our news, and the result is a keen competition between the seceders and those papers which continue to support the Company. We have every reason to be satisfied with the result of the struggle so far as our prestige is concerned. But wars, whether between nations or individual opponents, cost money. Without venturing to prophesy, we may fairly express the hope that the seceding papers may eventually see the futility of squandering money in the effort to compete with an organisation whose sole reason to be is to supply the Press with intelligence more cheaply, regularly, and expeditiously than is possible under separate arrangements by individual members of the Fourth Estate (cheers). These, gentlemen, are all the remarks which we deem it necessary to make. I now propose "That the report and accounts now presented be received and adopted, and entered on the minutes." Before putting the motion I shall be happy to answer any questions.

Admiral the Right Hon. Sir JOHN C. D. HAY, Bart., K.C.B., seconded the motion.

The resolution was put to the meeting, and carried unanimously.

The CHAIRMAN moved that Baron de Reuter, who retired from the Board in conformity with the Articles of Association, be re-elected a Director. Baron de Reuter, as they were aware, was the originator of the Company, and had been for a long time, and it was to be hoped would continue to be, its "guide, philosopher, and friend." The Baron was not in very strong health, and was seeking health in a milder climate; but when the weather became warmer the Directors hoped to see him back and at work again. Whenever the Board found themselves in any difficulty (which sometimes would happen in all companies) they applied to Baron Reuter, and were guided by him.

ADMIRAL Sir JOHN HAY seconded the motion, which was put and carried.

Mr. BRADSHAW said he had pleasure in moving that Messrs. Quilter, Welton and Co. be re-elected auditors, with a remuneration of 25 guineas.

Mr. FROST seconded the motion, which was put and carried.

The CHAIRMAN: Gentlemen, that concludes the business, and I have to thank you for your attendance.

Mr. MAURICE GRANT, who entered the room just as the proceedings closed, said he had one or two remarks to make, but he did not know whether he should be out of order.

The CHAIRMAN said it was not strictly according to the law of companies to enter upon any discussion when the meeting had clo ed; but if Mr. Grant wished to make any remarks he was sure the Board would be glad to listen to them.

Mr. GRANT said it was not a case of poverty with the newspapers; they were making large fortunes, and at the expense, as he thought, of this Company. The expenses of the Company were too heavy, and they were charging too little for the information which they furnished. He thought a dividend of 5 per cent. in a Company of this kind was not sufficient.

The CHAIRMAN said that every business nowadays had to contend against keen competition, and profits were cut down very considerably, and that accounted for the small return from so large an outlay. The outlay was of a very peculiar kind. The Company had to keep up a good staff; they could not go into the next street and pick up clerks who could merely write and cipher, but they required to have cultivated and intellectual men, and these they had, most of whom had been for years in the Company's employ. And if they had not men of intelligence and general knowledge they would not get on (hear, hear). The Company did not get large returns for their labour, but they did get returns. It was not from any want of endeavour on the part of the Directors that the Company did not pay more. Most of the leading papers had their own correspondents, and if the Company did not keep them supplied with information the papers would supply themselves. The cause of the profits not being larger was the keen competition. The shareholders might be sure that the Directors, who had had many years' experience in the work, did not neglect any means by which a fair return could be had for the money. He did not think any body of men could take more pains than the Directors to cut down unnecessary expenses.

Mr. GRANT said he should make it his business to see whether the Company could not pay more than that.

A SHAREHOLDER said he was a large shareholder, and had also an interest in an unfortunate newspaper, and, speaking in the latter capacity, his impression was that the Company had considerably raised their charges from time to time (a laugh).

Mr. GRANT said he had pleasure in moving a vote of thanks to the Chairman and Directors.

A SHAREHOLDER seconded the motion, which was put and carried.

The CHAIRMAN acknowledged the compliment, and added: I assure you, and I assure you with a very long experience of the matter, we have found it quite impossible up to the present time to persuade the newspapers to increase their subscriptions, and I think, sir, we shall look upon you as the best friend of the Company if you can persuade the newspapers to adopt a more liberal way (hear, hear).

The proceedings then terminated.

Western and Brazilian Telegraph Company (Limited).

The fifteenth ordinary general meeting of this Company was held at Winchester House, 50, Old Broad-street, yesterday (Thursday), under the presidency of Mr. W. S. Andrews.

The SECRETARY (Mr. R. M. Cunningham) read the notice convening the meeting, and the minutes of the former meeting, and the report of the Directors was taken as read.

The CHAIRMAN, in the course of his opening remarks, said: The first matter I have to allude to is the retirement of our late Chairman, Sir Henry Drummond Wolff, on account of his appointment as British Minister to the Court of Persia. The vacancy created by that retirement was filled by the election of Lord Richard Browne, a gentleman of considerable experience in the management of traffic companies, which is the leading characteristic of the Company that I am speaking on behalf of to-day. My co-Directors have elected me as Chairman of the Company. We bring before you to-day, I am very pleased to observe, a state of prosperity which is unexampled in the history of the Company. You will remember that it has been our pleasing duty from time to time of late to draw your attention to the increases which have taken place in the revenues of the Company. That was not alone the case in 1885, but it was the case in 1886, and so I am glad to say it is the case in 1887. The increase in the gross revenue for the last year is no less than £21,000. In 1885 the revenue had reached £127,396, in 1886 it was £138,666, and in 1887 it has reached what I may almost term, looking at our affairs, the grand total of £159,789. Of course, an isolated increase is satisfactory, but an increase following upon other increases is still more satisfactory, because it seems to show a growing state of prosperity, arising from a continual increase of business between those countries who have these telegraphic communications. Our increase over the year 1885 amounts to upwards of 25 per cent., and our increase over 1886 to upwards of 15 per cent.; and although it does not come properly into the operations of the year now under discussion, I may tell you that at the present time the year 1888 shows a satisfactory increase over the corresponding period of 1887. That increase would have been larger but for an interruption to one of the cables, which took off a good deal of money from our line. I shall deal with that presently. The increase of revenue standing at over £21,000, it is satisfactory to observe, as the total outcome of abstracts A, B, and C, that there is only a difference of £207 increased expenditure. True, on the whole, there is a total increase of £1,712 in the expenses, but of that £1,200 is occasioned by our having had to put into the line a greater length of new cable in substitution of the old unsuitable type, whose history you are most of you well acquainted with. Therefore that is an item beyond our control, but in a sense we look upon it as a pleasing fact, because is is only the continuation, in an accidental way, of the fixed policy of this Board to improve the communications upon which, of course, the prosperity of the Company entirely depends. If you care for an analysis of those expenses I shall be very happy to give them to you. Under Abstract A there is a net increase of £2,259, of which £1,785 is in salaries and wages. Shareholders always look at these items with a considerable degree of attention, and I think they are right in doing that, because they are a constant item in the expenses, and there is a constant tendency in them to grow year by year. The Directors do their best, and I think I shall show you that we have done so in this particular case, as all through, to keep the expenses down as far as we can, and some of the expense is more nominal than real. As regards salaries and wages, the increase in that item is made up of five new clerks whom we had to send out to deal with the increased business; and that is an absolutely unavoidable expenditure if you are to do your work creditably and well, and unless you do it in that way you will not get the work. That accounts for £800. There has been a rise in exchange, but the effect of that upon the expenses is this, that we pay the men and we pay for our material the same number of milreis, but they have an enhanced value. Consequently in that £1,785 there is £537 for difference in exchange. There is a total of £1,300 of that sum, and the rest is made up of mechanical promotions of the clerks who go out under agreements, and whose salaries are subject to increase after terms of service. Therefore as you see the whole of that arises mainly from the increase of business, and it is not an avoidable expenditure. The only other item above £100 is for new instruments, £111, which is another unavoidable expenditure. Under abstract B, singular to say, there is almost the same decrease as there is increase under abstract A. Under abstract C there is only a total increase of £470. The outcome of all this is that upwards of £21,000 increased revenue has been earned at an additional outlay of just 8 per cent. And in reference to that figure I would say this, that I should very much like to get an increase of £100,000 on the same terms. The increase under certain heads of expenditure is misleading, because of the exchange. You must remember that we receive for our messages a great deal more money, and we are receiving a great deal more than we are paying away. That I may best illustrate by mentioning this fact to you, that whereas at times we have been losing on exchange up to as much as £10,000 a year and over, our loss in the past year did not exceed £1,500. Without going further into details, I may say that after crediting the reserve fund with £15,000, and after putting by £10,000 to the debenture redemption fund, we are enabled to pay you a dividend of 3 per cent., making, with the interim dividend, 4½ per cent. for the year, and to carry forward £3,464. As I began by saying, so I now end by saying, that that is the best account that we have ever presented to you, though I hope it will not be the best in the future. Certain things hang together, and they are rather big questions, namely, the debenture redemption fund, the reserve fund, and the new cables. Taking the last first, I think I have already drawn your attention to the fact that this year, owing to interruptions, though our receipts are better than for the previous year, they would have been still better by some thousands of pounds but for the interruption mentioned. We have had it seriously under consideration for some time, looking to the growth of the business of the Company, and the importance of preserving its prestige in the eyes of the public, to do something on certain sections to strengthen the system. As guiding us in the consideration of the matter, we have been thinking what it is that has built up the revenue of this concern, because it is an increasing quantity, whereas before it was a diminishing quantity. That arose from the fact that your cables were of a faulty type not calculated to do the work as it should be done, and at the very time when commerce was active, and plenty of money was to be made,

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you were perhaps broken down. Here I must recognise the zeal and energy of the Managing Director, Major Wood, the Secretary, and the staff at home, and especially those in Brazil, who have all the actual work to do. What has built up this system has been the determination of the Board to place the cables in thorough working order. For that we had to take revenue and the reserves, and owing to the persistent application of these means to that purpose, we have a line that does its work extremely well. With respect to any new cables we should obtain tenders for them, in order to get them, as we should do, at the best market price of the day. With respect to raising the money for that purpose, our reserve fund would be partly appealed to, and other methods would be adopted, which the Board has been, and indeed still is, carefully considering. You will, no doubt, see that the stability of the concern will influence the price when we do call for tenders for the laying of the new cable. It is very advisable for us to continue our past policy in your interests, and strengthen the position of this concern. We thought, therefore, that we were bound, as prudent men of business, to see the amount required for the debentures at least a year or two in hand, and there is something behind that. Mr. Goschen shows by his conversion scheme that he saw that the time had arrived when securities, having a considerable time to run—at least, a good fixed permanent period, with a low interest and good security—were a very favourite investment. Our present debentures are 6 per cent.; but, fortunately for us, they are terminable debentures. They are debentures which in a couple of years we shall be drawing, and we shall be drawing them every year in increased amounts. It strikes me that an investor will scarcely care to go into the market and pay a large premium for a thing which next year, or within a year or two, may be redeemed at par; and that is a result of our policy. If we can show our undoubted strength to redeem those debentures, if we can show our financial stability with our reserves and security as an investing concern, then gentlemen may say to themselves that a debenture with a greater element of permanency, if with a smaller amount of interest, will command a better price in the market. I will now propose

"*That the report and accounts to the 31st December, 1887, be and they are hereby approved and adopted; and that, in accordance with the recommendation of the Directors, a final dividend of 3 per cent., or 9s. per share, free of income-tax, be declared for the year ended December 31st, 1887, payable on the 1st May next.*"

Mr. H. WEAVER seconded the resolution.

A short discussion followed, and in reply to questions,

The CHAIRMAN stated that the cables were now working all right from end to end. The length of the cable was 3,700 miles. They did not propose to duplicate the whole system for the present, at all events, and the necessity for doing so had not arisen. The delay in the repair of the last break was caused by the absence of their ships at the two extremities of the line, and by bad weather when the ship got on the spot. The moment the weather moderated the repairs were effected. They had at present no negotiations with the Brazilian Government. He would not say that the Directors would dismiss from their minds any idea of negotiations for the future, because it was never advisable to deprive oneself of an option. They might, by and bye, if circumstances were favourable, exercise the option of renewing the negotiations; but they might rely upon it that any course which the Directors took in connection with this matter would be in the best interests of the shareholders.

The resolution was then unanimously carried.

On the motion of Mr. C. W. EARLE, seconded by Mr. GUESDON, Mr. Andrews was re-elected a Director of the Company; and on the motion of the CHAIRMAN, seconded by Mr. GUESDON, Mr. Weaver was also re-elected to his seat at the Board. The auditor (Mr. Weise) was next re-appointed, a long and, in the result, abortive discussion following a suggestion from a shareholder as to the appointment of a second auditor—a proposal for which the Directors saw no necessity, and respecting which the opinions of the shareholders were divided.

The SECRETARY then read the notice convening the extraordinary general meeting, at which it was notified that the following resolutions would be submitted:

1. *That the 6th and 7th Articles of Association, and so much of the 26th Article of Association as includes and follows the words, "but notwithstanding any rule of law or equity to the contrary" shall be cancelled.*

2. *That Article 50 shall be modified by the insertion, after the word "yearly" of the words, "and may be held half-yearly."*

3. *That the agreement, dated 18th April, 1888, between The Western and Brazilian Telegraph Company (Limited), of the one part, and The London Platino-Brazilian Telegraph Company (Limited), of the other part, be, and the same is hereby approved and confirmed, and the Board are authorised to carry the same into effect.*

4. *That, for the purpose of the said agreement, and other the purposes of the Company, the capital of the Company shall be increased to £1,500,000 by the creation of 30,000 Shares of £15 each, to rank pari passu with the existing Ordinary Shares of the Company.*

5. *The Directors may issue the shares required, for the purposes and on the terms of the said agreement. The residue of the said shares may be issued by the Directors at such times, in such manner, and upon such terms as they determine.*

The CHAIRMAN explained with reference to the proposed modifications in the Articles of Association, that the changes would remove certain objectionable features in the present Articles, with which the present Directors had had nothing to do.

Mr. GUESDON was strongly of opinion that the proposed alterations, though in the right direction, did not go far enough. He had no objection to the issue of proxies—on the contrary; but he protested against the issue of stamped proxies.

Mr. WEAVER stated that they were not stamped now at the expense of the shareholders.

Ultimately resolutions 1 and 2 were agreed to, an alteration being made in the latter, by which it was made definite that half-yearly meetings of the Company will in future be held.

The SOLICITOR then read the proposed agreement between the Company and the London-Platino-Brazilian Telegraph Company.

The CHAIRMAN stated that by the proposed arrangement there would be a more intimate working connection between the two concerns, which would be brought under a common control with a common proprietary. The line was one continuous cable. The upshot of the arrangement was that of the £1,500,000 to which it was proposed to increase the capital of the Company, about £345,000 would go the Platino Company, supposing all that Company's shares to be exchanged, as stated in the report, and there would remain 7,090 shares unissued. After fully considering the arrangement, the Directors strongly recommended it to the shareholders. He then proposed the third resolution.

Mr. WEAVER having seconded the motion, considerable discussion ensued, Mr. GRIFFITH doubting the validity of what was proposed, and Mr. GUESDON maintaining that the terms were more favourable to the Platino Company than to the Western and Brazilian Campany, and complaining—as did another shareholder—of the proposal to compensate the Directors of the Platino Company for their loss of office.

The CHAIRMAN pointed out that the Directors of the Western Company would in future undertake for nothing the duties which had hitherto been discharged by the Board of the Platino Company.

The resolution was eventually declared carried, with 12 dissentients; and resolutions 4 and 5 were afterwards approved.

The proceedings terminated with a vote of thanks to the Chairman and Directors.

The Oriental Telephone Company (Limited).

The eighth ordinary annual general meeting of this Company was held on Wednesday at the City Terminus Hotel, Cannon-street, Mr. William Addison presiding.

The SECRETARY (Mr. Alexander B. Chalmers) having read the notice convening the meeting,

The SOLICITOR (Mr. Joseph Addison) said: Gentlemen, since the report was sent out a case has been submitted to counsel with reference to dividends which were paid in previous years. The dividend which has been mentioned in the present report is one which has been duly and fairly earned on the working for this year, but it occurred to the Directors after the notice was sent out whether anything might arise as to the payment of the dividend for the past year, and I was directed to submit a case for the opinion of counsel, whether or not the dividends which had been declared in the years 1882-3 were dividends which, as events have now turned out, could have been said to be truly and properly earned. Counsel's opinion has thrown considerable doubt upon this question, and it is only this morning that we have received that opinion, and therefore I have taken upon me the responsibility of advising the Board of Directors to this effect, that however justly they have earned the dividend during the present year, they must really carefully consider the effect of that opinion before they assume the responsibility of paying the present dividend out of the funds of the Company. I think they will do very wisely if they will first consider carefully and accurately the value of their patent rights and of their business as they now stand. It is a little unfortunate that counsel's opinion has been only just received, but the Board having fully considered the matter, think that the best thing they can do will be to ask you to allow the meeting to be adjourned for a month, when they will be prepared to lay before you their final decision, and, if thought right, recommend the dividend they had proposed to be approved to-day.

The CHAIRMAN then formally moved the adjournment of the meeting for a month.

Mr. B. ST. JOHN ACKERS: I rise, gentlemen, to second the proposition of our Chairman that this meeting do adjourn for a month. I was asked to second the suggested payment of a dividend at this meeting, and I should have far rather done that than what I am now asked to do; but I think this is so important a question, and one which touches the well-being of our Company so much, that I think it would be very unwise to come to any decision to-day. As you have heard from our legal adviser, we have every reason to believe that the dividend we were to recommend to you to-day will this day month be proposed, and, if the shareholders agree to it, declared; but until we have gone thoroughly into this question of back dividends and seen whether or not our capital has been reduced, as has been suggested, I think it would be very unwise to come to any decision. I therefore ask you to adjourn the meeting. But do not go away in the smallest degree despondent; we have had a very favourable year. We have earned quite sufficient to pay a reasonable dividend, and we have good prospects of paying you good dividends for the future. All that we ask is that we may have time to protect ourselves against doing anything that we ought not to do in the eyes of the law.

The CHAIRMAN having put the motion, it was agreed to, and the proceedings terminated.

The Maxim-Weston Electric Company (Limited).

The seventh ordinary general meeting of the above Company, which was adjourned on the 28th of March, was resumed on Wednesday last at the Cannon-street Hotel, to receive the report of the committee appointed at the first meeting to investigate and report upon the affairs of the Company. Mr. Hugh Watt, M.P., presided.

The notice convening the meeting having been read,

The CHAIRMAN called upon one of the members of the committee to read their report.

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Mr. KLENCK, having briefly recapitulated the circumstances under which the committee were appointed, then read the following report:—

"(1) The committee have now to report that on going into the affairs of the Company much of their time was wasted by the obstacles put in their way when they desired access to the books and documents, and they have specially to report that up to the present time they have been unable to obtain an inspection of the minute book of the Company. (2) The committee regret to inform the shareholders that the profit shown in the balance-sheet submitted to the last meeting was misleading, and was only arrived at by the omission to make any allowance for bad or doubtful debts, and by unwarrantably writing up an increased value in the stock and patents of the Company as compared with the valuations given in the balance-sheet for 1886. The committee further state that the item in the balance-sheet for December, 1887, of 'debtors £15,001. 12s. 6d.' includes some old and some disputed accounts, the recovery of which appears to be doubtful. (3) The committee report that Mr. Louis Swaby is still a Director of the Company, and that he has held, and still holds, the necessary qualifications to retain his seat at the Board. (4) The election of Mr. George Howell, M.P., as a director of the Company was irregular, as there has not been a properly constituted Board at which he could have been elected pursuant to Clause 77 of the Company's Articles of Association since the 16th ultimo, when he became a registered holder of 250 shares of the Company. (5) The committee are strongly of opinion that under the present circumstances of the Company it is most important that the directorate should be forthwith strengthened by the addition of three, or more, independent gentlemen of resolute character and commercial experience to represent the interests of the shareholders of the Maxim-Weston Electric Company. (6) The committee approach the grave question relating to the Watt dynamo machines and the Watt arc and incandescent lamps with considerable hesitation, as they are informed by Mr. Watt that these patents are not the property of your Company, but belong to himself and others. The committee consider that steps should immediately be taken to secure the same for the Company, as they find that the energies of the officials and workmen have been mainly directed, and the plant, machinery and premises of the Company have been and are now almost exclusively used, to develop and perfect the Watt patents, and considerable amounts of the Company's money have been expended upon them. Moreover, your committee maintain that Mr. Watt's personal interest in the Watt patents can only be held in trust by him for the benefit of the shareholders of the Maxim-Weston Electric Company (Limited). (7) In concluding their report the committee venture to express their opinion that the business of the Company could be efficiently carried on at a much reduced cost.

(Signed) "J. M. KLENCK, Chairman.
"HENRY A. GREIG.
"GEO. H. HILYARD.
"JNO. MARKS.
"London, April 24, 1888." "JOHN NEWTON.

Mr. KLENCK, continuing, said that while he claimed his right to reply to any remarks which the Chairman might choose to make, at the same time he would venture to make some additional observations by way of explanation. He thought they had to thank Mr. Greig for the determined manner in which on the last occasion he moved the rejection of the report and balance-sheet, in order that an investigation of the affairs of the Company might take place. They had also to thank Mr. Dever for the qualifying letter which he added to the accounts of the Company, for if it had not been for that letter he (the speaker) was quite certain that a large number of the shareholders present at the last meeting would not have voted for the adoption of the accounts. In 1886 the patents account was £38,229, in round figures; whereas in 1887 it was written up to the extent of £40,737. That increase was made up as follows:—Cash, £44; wages at the works, £718; salaries (including Mr. Watt's experimental work) £750, and Mr. Watt's manager £200, and goods used and destroyed by experiments £325. Now came a most important item, £470 for salaries, which had been written up to patents account, as follows:—£100 to Mr. Wright, as secretary, although he (the speaker) could not understand what that gentleman had to do with the patents; £270 for office expenses, and another £100 for general office expenses, making the total he had mentioned. The stock of machinery, lamps, &c., at the factory in 1886 was £13,440. 12s. 4d., whereas in 1887 it was credited at £19,817. 7s. 6d. The plant, machinery and tools stood at £2,970. 4s. 9d. in 1886, and were written up in 1887 to £3,603. 15s. 2d.; in other words, the stock, patents and machinery, which in 1886 amounted to £54,640. 14s. 2d., were written up in 1887 to £64,158. The committee, however, failed to prove the increased value in the stock as compared with 1886, their own opinion being that a certain amount ought to have been written off instead of written up. They had not gone into any personal matters as between Mr. Swaby and Mr. Watt, not deeming those questions within their province. Mr. Brown retired from the Board on the 3rd March, and from that date (Mr. Swaby not having attended at the offices of the Company) they consequently held that all business done up to the present was done illegally, because there was not a quorum of the Board. Now he came to the most important of the whole business, and it was this, that they considered that Mr. Watt should only hold the patents of the Watt dynamo and the Watt arc and incandescent lamps in trust for the Company. Mr. Watt had used part of his salary in experiments, and written it up to patents; he had used their offices, their works, their machinery, and their wages in all his experiments, and the committee held that those patents were held, and should only be held, in trust by him for the benefit of the Company. He concluded by moving the adoption of the report.

Mr. HILYARD seconded the motion, and in the course of his remarks said that after a good deal of trouble he had discovered that the Company in 1887 turned over £7,500 in business, but to do that it had cost them £4,651. He held that there was a loss on last year's working of £2,000.

The CHAIRMAN said that after taking legal advice he found that they could do almost nothing at that meeting, because it must first be determined who the Board of Directors really were. Personally he had no animus against Mr. Swaby or anybody else. He had done the best he could for the Company. [A voice: You have done the best for yourself (laughter)]. At any rate, if that was the case, Mr. Swaby would bear a share of the onus. At the same time, he would remind them, and Mr. Swaby would agree with him. that some time ago he (the speaker), owing to other engagements, and, in fact, feeling that the business was too heavy for him, was anxious to retire from the Board, and no one more than Mr. Swaby thought that it was in the interests of the Company that he should remain, and, in fact, Mr. Swaby even pressed him to an engagement to do so. The matter was now entirely in the hands of the meeting. He had said before, and he said again, if Mr. Swaby or anybody else cared to take up the office he would willingly part with it. He held 8,000 or 9,000 shares in the company, and from first to last he had not made any money out of the concern. Even at the last meeting of the committee he had said that he was willing to forego a large portion of his remuneration to a manager who would relieve him of many of the details of the work he had done—in other words, that he was willing to pay a manager out of his own pocket. They had been placed in this position with regard to the past year, that inasmuch as dynamos which could be produced cheaper than theirs had been made in 1887, they had found it impossible to secure a great many of the contracts, which, judging from their experience of 1836, they had a right to expect. They had added to the patents account the amount stated, which he had mentioned at the last meeting. He was not there to dispute it. No doubt he had gained experience in connection with the Company, but it had not enabled him to work out the Watt system, because he told them frankly and fairly that the original plans for that system were not of his initiation. He advanced a certain amount of money for the patents on the distinct condition that the Maxim-Weston Company should benefit by them. He did not agree with the committee that the Company was virtually nothing without them. Mr. Swaby, more than Mr. Brown, wanted an arrangement made to secure them. [Mr. Swaby: I beg to deny that.] He would waive the point since Mr. Swaby dissented. He wished to be perfectly fair in his statements. There could be no doubt that the provisional arrangement come to with regard to those patents was that they could make the machines, and they had to pay a certain royalty; but if they sold nothing they had to pay nothing. Coming to the accounts, they had been prepared upon a basis, as far as he understood the matter, agreed upon between the auditors and the professional accountant who kept the books. It was a question, of course, for the shareholders to say whether their estimates were correct or not; but in a matter of that kind, he thought that they would agree with him that it was a proper subject for an expert only. It was hardly one for an ordinary business man, because they were dealing with scientific and mechanical appliances as well as commercial affairs. He affirmed and maintained that the books as kept were absolutely correct. He had five or six years' experience in connection with the Company, and that was the conclusion he arrived at. The accounts had been prepared in the same way as those of other electrical companies. If they did not wish to have the Watt patents they could lose them, and. provided the expenses were paid, they would be taken out of his hands altogether. Their chief concern in connection with the Company must necessarily be its future welfare, and the proposal that he would make in view of the committee's report was that 20 or any other number of the largest shareholders of the Company should be appointed to confer with the existing committee as to what would be best to be done in the interests of the Company, as their present uncertain position, and the recent meetings that were held, had caused them to lose business. [A Voice: What business?] The Chairman then referred to the fact that, but for those drawbacks, the Company might have been able to secure a contract for lighting from the Corporation of Bradford, involving an outlay of £10,000. It had been said that obstacles had been thrown in the way of the Committee, but the only thing that they had not received was the minute-book of the Company, and that had been withheld at the instance of Mr. Hawes, the solicitor. I am very glad to see Mr. Henderson here; he knows that under the old *régime* the contract with the Corporation was the ruin of the Company.

Mr. HENDERSON: Do not ask me to endorse what you say (cries of "Order"). I think you make random statements (interruption, and cries of "Oh, oh.").

The CHAIRMAN: It is the first time I have been told so, and I shall not address myself to you again. What I was going to say is this—that we may be greatly assisted by Mr. Howell in obtaining contracts we hope to secure from other Government departments.

After a good deal of discussion, in which Mr. Griffiths, Mr. John Newton, Mr. Henderson, Mr. Klenck, and others took part,

The CHAIRMAN moved as an amendment "That the report of the committee be not adopted."

Some further discussion having taken place,

Mr. MEREDITH moved, as an amendment, "That the committee's report be rejected."

Mr. GRIFFITHS having seconded it,

The CHAIRMAN put it to the meeting, and declared it lost. He then put the original motion, which he declared carried, with five dissentients.

The CHAIRMAN then proposed, and Mr. KLENCK seconded, "That 16 of the largest shareholders, or as many of them as will agree to act in conjunction with the present committee, be appointed as a committee to report to the shareholders as to what is best to be done in the interests of the Company, and to take an early opportunity of submitting their report to the shareholders, five to form a quorum."

The motion having been agreed to,

Mr. NEWTON proposed, and Mr. KLENCK seconded, the re-election of the auditors, and a vote of thanks to the Chairman having been passed unanimously, the proceedings terminated.

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CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended April 20th, 1888, amounted to £4,104.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The coupon on this company's 5 per cent. Debentures (1880 issue) due on the 1st May proximo, will be payable on and after that date on presentation of the same at the Consolidated Bank, 52, Threadneedle-street, E.C. Coupons should be left three clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended April 20th, 1888, after deducting the "fifth" of the gross receipts payable to the London-Platino-Brazilian Telegraph Company (Limited), were £3,390.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The directors of this company, owing to improvements of revenue derived from exceptional causes and some increase in the traffic, recommend a dividend of 10s. per share on account of arrears of dividend on the First Preference Shares, as compared with 6s. a year ago.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, April 25, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending April 25, 1888. Highest.	Lowest.
			TELEGRAPHS.					
£					£ s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	38 39	3 10 6	Jan., Apr., July, Oct.	38¾	38⅛
2,614,820	Stock	20/0	Do. Preferred	64½ 65½	4 3 4	,, ,,	65	63¾
2,614,820	Stock	nil.	Do. Deferred	13 14	...	February	13¼	12⅞
130,000	£10	3/0	Brazilian Submarine	12¼ 12½	5 12 0	Mar., June, Oct., Dec.	12 7/16	12¼
16,000	10	8/0	Cuba Submarine	12¾ 13¼	6 0 9	February and August	13⅛	13
6,000	10	10/0	Do. Preference	19 20	5 0 0	,, ,,	19½	...
12,931	5	2½%	Direct Spanish (£4 paid)	3¾ 4¼	3 10 0	March & September	...	...
6,000	5	5/0	Do. Preference	9 10	5 0 0	April and October ...	...	...
60,710	20	2/0	Direct United States	8⅝ 8⅞	4 11 6	Jan., Apr., July, Oct.	8⅝	...
380,000	10	2/6	Eastern	11⅜ 11⅞	4 12 7	,, ,,	11⅝	11⅜
70,000	10	3/0	Do. 6 per Cent. Preference	14¾ 15¼	3 18 0	,, ,,	15¼	14⅞
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅞ 13⅜	4 19 1	Jan., Apr., July, Oct.	13⅛	12 15/16
22,050	10	5/9	German Union Telegraph and Trust	9 9½	6 3 3	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅞ 6⅛	4 12 0	Jan., Apr., July, Oct.	6⅛	5 15/16
178,992	10	3/0	Do. 6 per Cent. Preference	13⅞ 14⅛	4 4 11	,, ,,	14 1/16	13⅞
150,000	10	5%	Great Northern	14½ 15	5 0 0	Jan., July, and April	15	14¾
17,000	25	5/0	Indo-European	38 40	6 5 0	April and October ...	...	...
38,348	10	3%	London Platino Brazilian	5½ 6	5 0 0	May and November	5 11/16	5 9/16
9,000	8	4/0	Reuter's	7¾ 8¼	7 6 3	April and October ...	8	...
338,225	Stock	12%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	5¼ 5¾	8 13 9	January and July ...	...	...
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88,321	10	nil.	West India and Panama	¾ 1	...	...	⅞	...
34,563	10	9/0	Do. 1st Preference	10½ 11	6 19 6	April and October ...	10 3/16	...
45,181	15	3/9	Western Brazilian	9⅜ 9⅞	7 18 5	March & September	10 3/16	9 9/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅝ ¾	5 9 0	Yearly	...	...
220,000	£1	...	Oriental (11s. paid)	5/16 7/16	...	...	...	...
80,000	5	5/0	United	14¼ 14¾	4 8 2	June and December	14¾	14¼
50,000	5	2/6	United River Plate	5 5½	...	April and October ...	5 3/16	5
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb. '86	Anglo-American Brush (£4 paid)	2¾ 3¼	...	...	2⅞	...
23,692	5	nil.	Do. (fully paid)	3½ 4	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅜ 2⅝	...	...	2 9/16	2½
312,000	½	0/1½d. '86	Maxim-Weston	1/16 3/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	39½ 40½	5 18 6	March and July	40½	39½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	17⅝ 18⅛	5 8 1	February & August	18	...

PATENT

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THE ELECTRICIAN:

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NOTES.

The long and interesting speech delivered by Prof. Forbes at the last meeting of the Society of Telegraph-Engineers was received with much enthusiasm by the advocates of alternate-current distribution, who very much appreciated the scathing criticism of Mr. Crompton's figures. Prof. Forbes brings down the estimate for a 10,000-light plant on this system from £57,440 (where Mr. Crompton left it) to £34,140—a reduction of over 40 per cent. Comparing this with the battery system at £59,652, it is no wonder that the transformer men felt that the argumentative victory was practically theirs. But it seems necessary to observe—as Mr. Gordon did not fail to do—that even if Prof. Forbes's figures be accepted, his demand for overhead wires raises a practical difficulty which has still to be faced. On the other hand, we quite agree with Prof. Forbes that the conditions chosen by Mr. Crompton are not those which allow the transformer system to display its merits at the fullest advantage. For instance, we should like to know how the battery system would compare in such a case at that now actually in progress, where a large installation in the City of London is to be supplied with current from a station at Deptford.

With regard to the extremely interesting figures given by Mr. Gordon from his contract with the author of the Paper, we are at a loss to understand how the efficiency of any battery can be guaranteed to be "not less than 90 per cent." at any rate of discharge. Prof. Forbes has, moreover, proved that the Howell battery must have a still higher efficiency in order to fulfil the conditions of Mr. Crompton's Paper. What do these figures mean? Unless the Howell battery can be charged at less than 2·5 volts, or discharged at more than 2 volts per cell, there must necessarily be a loss of 20 per cent. to begin with. However, even if its efficiency be somewhat less miraculously high, it is satisfactory to hear of a battery which the makers are prepared to maintain at 12½ per cent. on the contract price.

The specimens of switches, safety fuses, &c., used by the Westinghouse Company and shown by Prof. Forbes on Thursday evening were examined with considerable interest. Upon the whole we do not think that we have much to learn from American practice with regard to the minutiæ of electric light fittings. We illustrate two of the switches in another column. The single-lamp switch has a metallic handle which is only insulated from the contact pin by a thin washer; while the design of the larger switch is simply a marvel of misplaced ingenuity.

The Earl of Onslow, in the course of the discussion referred to in our leading article this week, stated that the Post Office could not legally incur expenditure which would not either prove remunerative or be guaranteed by those deriving benefit from it. In the House of Commons the same evening this point came up indirectly on Mr. McEwan's complaint that the Postmaster-General had declined to grant a working license to the proprietors of the Writing Telegraph. His refusal has been described as part of a policy which is a check upon invention; and in a certain sense no doubt it is so; but when the nation has made up its mind to a certain policy—in this case the control of the Telegraphs by the State—it must be content to make some sacrifices, and one of these is to disallow the free competition of inventions which cannot be advantageously adopted by or adapted to the State's telegraphic system. Many ingenious inventions—and the Writing Telegraph is certainly one such—are no doubt offered to the State, and declined for the simple reason, if for no other, that the Post Office is bound to enter into no unremunerative ventures, the cost of which is not guaranteed by those who desire them to be undertaken.

We sincerely sympathise with the Rev. G. H. Staite in his endeavours to attract attention to the merits of his unfortunate father's early experiments in the field of electric lighting, although the quarter in which the claims were first set forth was not calculated to inspire the world with confidence in their genuineness. Since then the reverend gentleman has addressed himself to the more appropriate columns of *Invention*, and with all the leading facts thus brought together one cannot deny to Mr. W. E. Staite a considerable share of the merit which his son claims for him. But, on the son's own showing, this merit has been fully admitted over and over again, and, so far as we know, has not been disputed. It is very sad that a life and a considerable fortune should have been sacrificed to an enterprise which failed chiefly, perhaps, because it was premature; but such stories are only too common, and from their very nature always reach us long after the mischief has been done and is past remedy. As to Mr. Staite's prior discoveries invalidating the patents of "Mr. Edison and Dr. Siemens," the vicar of Sutton Chesney "thinks" that they may; but before acting on what he thinks we should strongly advise him to take counsel of some one more sure of electrical science than he appears to be.

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THE JOHN PENDER banquet is likely to become historical, if only for the speech of Lord WOLSELEY, who made it warmer for party politics than some of its organs relished. One of them, the *Saturday Review*, although constrained to endorse all that his Lordship said, betrays its spitefulness by insinuating that the deficiencies in the next day's reports were afterwards supplied by the speaker himself. A fairer critic would have reflected that if Lord WOLSELEY had been anxious to be reported, he could have bespoke the newspaper reporters beforehand. It is not our business to defend the gallant general; but we feel it our duty to flatly contradict the insinuation above referred to, the fact being that our own report was the only one accessible to the daily papers; and this they gladly availed themselves of directly they learnt that the speech had been delivered, but certainly not at Lord WOLSELEY'S suggestion.

THE banquet itself has been the subject of much appreciative comment, the only exception, so far as we know, being that of a technical journal whose idea of submarine telegraphy appears to be that it could have got on very well without the help of money, or the discrimination and enterprise of those who possessed that commodity. Such is not at all our view, any more than it is ours that the electrical inventions which made the cables workable would have been devised if the cables had not been laid. The justice of this observation would be admitted probably by nobody more freely than the three or four eminent electricians who were unable to accept their invitations by reason of ill-health, professional engagements, or absence from the country, but whose non-appearance at the banquet has been seized with avidity in one quarter—but only one—for the purpose of depreciatory criticism.

THREE weeks have already elapsed since the commencement of the incandescent lamp patent trial, and the end is not yet in sight. Much of the evidence adduced on the part of the defendants has now been made public for the first time, and the interest of the proceedings tends to increase as the character of the defence is more fully disclosed.

ONE of the anomalies of our English Patent Law is strikingly exemplified by the constant references to a certain Mr. CHEESBOROUGH in the important trial now occupying the attention of the Courts. An outsider could scarcely fail to suppose that the aforesaid Mr. CHEESBOROUGH is a great and famous electrician; yet, so far as we are aware, Mr. CHEESBOROUGH'S title to renown rests upon no more solid basis than that of having, in his capacity of patent agent, "received a certain communication from abroad." Probably Mr. CHEESBOROUGH was as much in the dark as to the drift of this foreign intelligence as the public is as to the merits of the respective claims now being eloquently set forth in the Court of Chancery. The real claimants for the honour of having invented the so-called "flashing" process are, as most of our readers are aware, Messrs. SAWYER and MAN, of New York.

Mr. J. W. HOWELL'S Paper on the "Maximum Efficiency of Incandescent Lamps," read before the American Institute of Electrical Engineers, will be studied with great interest in this country. It contains the first published record (of a really trustworthy character) of the life of incandescent lamps, at various efficiencies. Unfortunately the results apply only to the Edison bamboo filament, a type which has almost gone out of use in this country. Since, however, it is expressly stated that the results do *not* apply to flashed filaments, we may, perhaps, hope to obtain the figures for the latter in a subsequent communication. It will be seen that the experiments have extended over a period of five years, and have involved the destruction of many hundred lamps. One word of criticism, or rather of inquiry, we venture to make. Mr. HOWELL does not tell us, as is usual in papers of this description on this side of the water, the conditions under which the experiments were carried out. What is most important is the method adopted for measuring the current and the difference of potential. A certain American electrician—though we do not for a moment suggest that Mr. HOWELL should be placed in the same category—has recently told us that the only kind of ammeter which is wanted in the States is one that a man can take to pieces and clean and re-calibrate for himself. Seeing that these experiments were commenced five years ago, it is to be hoped that the electrical measurements were not entrusted to instruments of this or, indeed, of any "commercial" type.

ACCEPTING the ascertained results, Mr. HOWELL'S experiments lead to an empirical law of a very remarkable character, which he thus formulates:—*The total cost of an installation is always a minimum when the cost of lamps is about 14·5 to 15 per cent. of the total cost of operation.* It is very difficult to understand how a law of this character can apply over any very wide range of conditions. Yet Mr. HOWELL has calculated curves for efficiencies varying from 2·38 watts per candle up to 4·32 watts per candle, for lamps costing from 25 cents to 1 dollar a piece, and for electrical energy at rates varying from 2 5 cents to 10 cents per horse-power-hour, each one of which curves shows a singularly close approximation to the law above stated. This is certainly a point which will repay more careful consideration than we are able to bestow upon it at this moment.

The development of a thoroughly practical petroleum engine capable of burning the crude oil would be an event of no small importance to the electric lighting industry, and would undoubtedly give a very great stimulus to the lighting of country houses and domestic lighting generally. The PRIESTMAN engine, which we describe in another column, seems to promise well for the fulfilment of the required conditions. Reports of a very favourable character have been made by Sir WILLIAM THOMSON, Sir SAMUEL CANNING, Mr. REDWOOD, and Messrs. ALABASTER, GATEHOUSE and Co.

THE question of a separate trade section in the London Chamber of Commerce devoting itself to the interests of electrical engineering is taken up again this month by our contemporary *Electrical Plant.* Taken up apparently to be dropped; for after a column of editorials given to its consideration, the subject is handed over to the Secretary, who

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is going to write a circular letter shortly to the parties concerned; "and in their hands" *Electrical Plant* "must leave it." Just so, "there let it lay," as Lord BYRON once wrote; but whether it will hatch anything remains to be seen.

Philip Reis.—Our readers will be interested to learn that the late Emperor William of Germany, very shortly before his death, signed a decree conferring a pension of 1,000 marks per annum on the widow of Philip Reis.

Bristol.—The Dean and Chapter of Bristol Cathedral have authorised Mr. Massingham, of Taunton and Bath, to undertake the lighting of the cathedral by electricity for the forthcoming musical festival in connection with the opening of the towers.

Telephoning to Trains in Motion.—M. P. Germain has carried out some experiments upon the French railways with a view to determining the possibility of communicating with a train in motion by means of a telephone, using the two rails as conductors. His experiments seem to have met with a considerable degree of success.

Mr. Wimshurst on Influence Machines.—At the Royal Institution on Friday last Mr. James Wimshurst lectured on influence electrical machines. There was a large audience, and at the conclusion of the lecture they had the opportunity of witnessing such a display of artificial thunder lightning such as few, if any, had seen before.

Barmen: A Correction.—In a "Note" last week respecting a central lighting station carried out by Messrs. Spiecker and Co., of Cologne, the name of the place was given as Bremen instead of *Barmen*. There is a central station at Bremen also, but this has been carried out by Messrs. Siemens and Halske, in conjunction with the Edison Company.

Telegraphs in the West Indies.—News has reached the Hague that the English steamer "Roddam" has successfully laid the cable between La Guayra, in Venezuela, and Curaçao. The same telegraph vessel is now engaged in laying the cable from Willemstad to San Domingo, which places Curaçao in direct telegraphic communication with Europe.

Suez Canal.—The progress made in fitting vessels with the electric light is shown by the Consular report from Port Said. It appears that while the number of vessels passing the Suez Canal with the electric light was in January, 1887, only 13, and in February only 12, the monthly number increased steadily until in December last 73 vessels navigated the Canal with the electric light.

Lecture on the Electric Transmission of Sound.—A lecture is announced to be given at S. Matthias' Schools, Kensington, by Mr. G. W. Tunzelmann, B.Sc., on Friday, May 11, at 8 p.m. The lecturer will give a brief history of the rise and progress of telephony, and some interesting experiments will be shown, including telephonic transmission of music. The proceeds will be given to the church schools.

A Magnetic Crane.—At the Otis Iron and Steel Works, Cleveland, Ohio, an electro-magnet is employed to lift the steel ingots and other heavy masses of iron. The magnet consists of two rods of soft iron 14in. in length and 3in. in diameter, united by a cross bar of square section. It is wound with a No. 14 B. and S. gauge covered copper wire, and when excited by a current of 6 amperes it lifts a weight of 800lb. with ease.

The Lighting of the City.—At the meeting of the City Commissioners of Sewers (the City of London Lighting Authority) it was resolved that, as the application of the Gas Light and Coke Company for an opportunity to display in the City some new and improved lanterns for high-power burners was to be for an entire year, and to be carried out wholly at the expense of the gas company, the application should be complied with.

The Nordenfelt Electric Torpedo Boat. — Mr. Nordenfelt has an electric torpedo boat of an entirely novel character constructing at Messrs. Shuttleworth's works at Erith. The greatest secrecy is maintained as to the details of the vessel, but we understand (says *Iron*) that the torpedoes discharged from it will penetrate any torpedo net yet invented. This new vessel should not be confounded with the so-called "Nordenfelt submarine torpedo boat," with which it is intended to co-operate.

Mr. A. E. Kennelly.—Many of our readers will be interested in the following paragraph, which we take from a recent number of an American journal:—"At Edison's laboratory, Orange, N.J., a few evenings ago, a reception was given to the Contemporary Club, when an interesting address on electricity, especially as employed in Mr. Edison's inventions, was given by Mr. A. E. Kennelly. The guests of the evening were received and entertained by Mr. Edison and Mr. Batchelor, and were delighted with all they heard and saw."

Central Station Lighting at Earl's Court.—We understand that the House-to House Electric Light Company has taken a lease from the Metropolitan District Railway of the piece of land adjoining the West Brompton Railway Station situated between that station and the Brompton Cemetery, the area of the plot being 25,000 square feet, upon which the company proposes to lay down its first central lighting station, and to supply the district bounded by the Cromwell-road on the north, and the Fulham-road on the south.

Messrs. Saxby and Farmer.—We understand that Mr. John S. Farmer, of the firm of Saxby and Farmer, engineers, manufacturers, and telegraph-engineers and contractors, of the Railway Signal Works, Canterbury road, Kilburn, London, having acquired by effluxion of time the share and interest of Mr. John Saxby in the business, it will be carried on at the above works, as usual and as heretofore, under the style of Saxby and Farmer, and with the same management, staff, plant, patents, and appliances.

Proposed Reward for the Best Current Meter.—M. Lyon Alemand has given notice of a resolution in the Paris Municipal Council, proposing that the sum of 20,000fr. (£800) be awarded for the invention of a perfectly satisfactory current meter; the sum of 10,000fr. to be awarded as first prize, five premiums of 2,000fr. to the next best inventions. Should it be possible to use the meter with one kind of current only, continuous or alternating, then one-half of the above premiums would in that case be awarded. Finally, with a view, doubtless, of recouping themselves, the Council are to reserve the sole right to manufacture the successful meters, no royalties being paid to the inventors.

Southampton.—The Southampton Corporation at their last meeting adopted a recommendation of the Special Works Committee to light the Hartley Institution, Audit House, Guildhall, Holy Rood clock, and certain streets at Chapel by the electric light, by means of accumulators charged from dynamos worked by power obtained from the heat of the refuse destructor, sanction being given to apply for a loan of £1,440 for the purpose of carrying out the works. The annual cost of lighting of the places named by electricity is estimated at £151, whereas gas to the public institutions alone now costs £210 a year, and a total saving of £171 a year is contemplated by the new system.

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New Electrodes.—We understand that M. Bandsept has devised a new method of overcoming polarisation in primary batteries. The electrodes are made of finely divided material, which is formed into plates under pressure, while being impregnated with "gassified substances" chosen according to the ulterior use to which the plate is to be put. By means of a pulveriser these "gassified substances" are projected with great force on to the material, which is compressed as it gradually becomes impregnated. The jet is straight when the electrodes are thick, and spiral or centrifugal when it is necessary to impregnate the surface only. The same process may also be applied with advantage to the construction of plates for secondary batteries.

St. Catherine's Electric Lighthouse.—The Trinity House have just completed the erection of one of the largest electric lights in the world at the St. Catherine's Lighthouse, Isle of Wight. It will be in use, we believe, on the 1st of May. The dynamos and lamps are by De Meritens, and the driving power is provided by Robey's semi-portable engines. The whole of the work has been designed and carried out under the direction of Sir James Douglass, F.R.S, who has been unremitting in his attention to all the details of the installation. The resident engineer is Mr. H. C. Millett, who for many years occupied a similar position in connection with the lighthouse at Souter Point, between Sunderland and South Shields, and who has superintended the erection of the machinery.

Victoria Hotel, Manchester.—The Victoria Hotel, one of the largest in Manchester, has just been fitted with the electric light. The installation consists of two complete plants, each capable of running 250 16 candle-power lamps. The engines are 12 h.p. (nominal), vertical type, fitted with continuous lubricators, and drive, by means of link belting, Crompton compound-wound dynamo machines, working at about 700 revolutions per minute. There are about 400 lamps distributed through the main rooms and passages, including a large underground billiard room containing ten tables, each table being lighted by six 16 candle-power lamps. The contract was placed in the hands of the Manchester Electric Supply Company (Limited), and has been carried out by Messrs. Holmes and Vaudrey, the company's engineers.

Accumulator Tests.—Prof. von Waltenhofen has recently carried out at the Electro-Technical Institute a comprehensive series of experiments with storage cells of the Fahrbaky and Schenek, Reckenzaun, and Julien type. The chief object of the experiments was to ascertain the efficiency of each type, especially for tramway purposes; and to eliminate errors in estimating the degree to which the cells had been charged or discharged the experimenter based his investigation on three measurements, viz., the electromotive force on open circuits, the density of the electrolyte, and the potential difference when at work. The efficiency of the Reckenzaun accumulator was found to be 89·3 per cent. for the quantity, and 80·85 per cent. for the energy. For the Julien accumulator, the figures were respectively 89·7 per cent. and 83·4 per cent.; whilst the Schenek-Fahrbaky accumulator gave 91 per cent. efficiency for quantity and 78·5 per cent. for energy.

King's College Engineering Society.—At a General Meeting of the King's College Engineering Society held on Tuesday, May 1st. Mr. A. H. Preece delivered his presidential address. He took for his subject the question of electric lighting from central stations, and described the following systems: (1) The direct parallel as still used in the Edison system in New York. (2) The three-wire system used by Edison in America, and patented by Dr. Hopkinson in England. (3) The direct multiple series proposed by Bernstein. (4) Distribution by means of alternate-current transformers. (5) Distribution by means of secondary batteries, as adopted by Crompton at Kensington Court. (6) Distribution by means of continuous-current transformers. He then proceeded to compare the system of transformers and that of secondary batteries, and concluded by stating the various charges to consumers made by the different electric light companies in England. After a vote of thanks had been passed to Mr. Preece the meeting adjourned.

New Method of Measuring Magnetism of Gases.—At a recent meeting of the Berlin Physical Society Prof. Helmholtz communicated the results of an investigation by Prof. Töpler, of Dresden, which he had the day before laid before the Academy of Sciences; it contains a new method for the measurement of the magnetism and diamagnetism of gases. An index drop of petroleum is placed in a glass tube bent at a very obtuse angle; on one side of the index is the gas which is to be investigated, and on the other side is atmospheric air. When placed between the poles of a powerful electro-magnet the index is moved according as the gas is more or less strongly attracted than the air; the amount of displacement is measured by a microscope. The delicacy of the method is extremely great. It was in this way observed that oxygen is most magnetic, then come air and nitric oxide; nitrogen, hydrogen, carbonic oxide, carbonic acid, gas, and nitrous oxide, on the other hand, are diamagnetic. The method employed in the above research can also be applied to the solution of various other problems, as, for instance, the determination of the pressure of small columns of gases.

Search Lights with Automatic Feed.—Search lights for naval purposes have hitherto generally been made with hand feeding gear consisting of two screws, that actuating the positive carbon having twice the pitch of the other, while the focussing was effected by a separate screw. This type of lamp is extensively used in our own navy; but as it requires one of the men to constantly watch the arc, several attempts have been made by the manufacturers of arc lamps to produce automatic feed gear for search lights. These find favour in some foreign navies, and we learn from *Industries* that Messrs. J. G. Statter and Co., of West Drayton, have now in hand for the Dutch navy four projector arc lamps, each for a current of 100 amperes, and self-feeding. The carbons are 30mm. in diameter, and the feeding mechanism is similar to that of their ordinary type of arc lamp, with hand screw for focussing the arc. Two projectors are supplied with these lamps, with Chance silvered mirrors supported in elastic brackets, so as to protect the mirrors from concussion when the guns are fired. In addition to the mirrors, the lanterns are fitted with divergers to fantail the light. The diverger when in use is put before the plate glass front, but can be swung back if a solid beam of light is required.

Formation of a Local Electric Lighting Company at Buckingham.—A public meeting to consider the advisability of forming an Electric Light Supply Company for the Borough of Buckingham was held on Wednesday evening. The Mayor presided. The hall was filled by a representative audience. Mr. Habgood read an interesting paper on "The Electric Light," and a discussion followed. The following resolutions were unanimously agreed to:—"That in the opinion of this meeting an Electric Light Power Supply Company (Limited) would be a great boon to the inhabitants of Buckingham and neighbourhood, and prove to be a great advantage and attraction to the town; that this meeting fully approves of the establishment of an Electric Light Company in Buckingham, and will use its utmost endeavours to make the same a great success." A vote of thanks

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was passed to Councillor J. W. Thorpe for the way in which he had taken up the gas question in the Council. The usual vote of thanks closed the proceedings, after which the preliminary steps for the formation of the company were taken. It appears that the chief cause of the proposed establishment of the company is the excessive charge of 5s. 3d. per 1,000 for the gas.

The Influence of Light upon Electric Discharge.—MM. Wiedemann and Ebert have recently followed up the discovery of M. Hertz by examining the influence of light upon the discharge in a Geissler tube. The following are the principal results which have been obtained :—When a static machine is used the effect of light falling upon the tube from an external source is to lower the difference of potential at which the discharge can take place. When an induction coil was employed the note given by a telephone in circuit with the tube was considerably modified by the influence of light. The effect appeared, however, to depend upon the direction in which the current traversed the tube. It attains a maximum for a certain pressure of the gas; this pressure differs also with the kind of gas employed. The part of the spectrum which produces the maximum effect varies also with the nature of the gas, and for carbonic dioxide the *least* refrangible rays of the visible spectrum are the most active. The phenomenon is probably connected with the fact of the intermittent or oscillatory character of the discharge—the intermittence not being merely due to the vibrator, but to the character of the discharge itself, and perhaps of the same order as the vibrations of light.

The Royal Institution.—The annual meeting of the Royal Institution was held on Tuesday, May 1, 1888, Sir Frederick Bramwell, D.C.L., F.R.S., Honorary Secretary and Vice-President, in the chair. The annual report of the committee of visitors for the year 1887, testifying to the continued prosperity and efficient management of the institution, was read and adopted. The real and funded property now amounts to above £81,000, entirely derived from the contributions and donations of the members. Forty one new members were elected in 1887. Sixty-three lectures and nineteen evening discourses were delivered in 1887. The books and pamphlets presented in 1887 amounted to about 283 volumes, making, with 463 volumes (including periodicals bound) purchased by the managers, a total of 746 volumes added to the library in the year. Thanks were voted to the president, treasurer, and the honorary secretary, to the committees of managers and visitors, and to the professors, for their valuable services to the institution during the past year. The following gentlemen were unanimously elected as officers for the ensuing year:—President, the Duke of Northumberland, K.G., D.C.L., LL.D.; Treasurer, Henry Pollock, Esq.; Secretary, Sir Frederick Bramwell, D.C.L., F.R.S., M.Inst.C.E.

The "Griffin" Gas Engine.—We have received a copy of a report by Prof. A. Jamieson on the "Griffin" double-acting gas engine, which has recently been placed on the market by Messrs. Dick, Kerr and Co., of 101, Leadenhall-street. Prof. Jamieson says:—

"The engine in its general style and behaviour more closely resembles that of an ordinary double-acting steam engine than any other gas engine with which I am acquainted, for both ends of the cylinder are closed in and an impulse is given to the piston every one and a-half revolutions, *i.e.*, combustion takes place at each end of the cylinder alternately every three revolutions of the crank shaft when the engine is working under normal conditions. This feature naturally causes the speed of the gas engine to be more constant than single-acting gas engines, and therefore better adapted for driving dynamos or other machinery where constant speed is required. . . . The engine has been specially well designed with the view of transmitting the working stresses to the foundation, and thus avoiding as far as possible any annoyance from vibrations and racking. Great care has been taken to make all the working parts strong and simple, while the workmanship and finish throughout seem to me all that could be desired. . . . The efficiency $\left(i.e. \frac{\text{brake horse-power}}{\text{indicated horse-power}}\right)$ amounted to 78·7 per cent."

Judging from this report, it would appear that the "Griffin" engine is likely to achieve a considerable success.

Lighthouse Communication.—In the House of Lords on Friday last the Earl of Morley called attention to the report of the committee appointed by the Board of Trade to inquire into the desirability of electrical communication between light vessels and outlying lighthouses and the shore. Signalling by means of rockets or guns was unsatisfactory, inasmuch as rockets could not always be seen and guns could not always be heard. In the substitution of telegraphy we should not be behind other countries if it could be proved that a change of system would conduce to the saving of life at sea.—The Earl of Onslow pointed out that it would be quite impossible to apply any portion of the mercantile marine fund towards the establishment of communication between lightships and lighthouses and the shore. If anything was done in this direction in the interests of commerce it must be done by the shipowners or by the Post Office, although the Post Office were bound by Treasury regulations to incur no expenditure which would not be remunerative, or the interest of which was not guaranteed by those deriving the benefit. Apart from the question of cost, the risk to the ships themselves by introducing telegraphic connection with the shore must be considered. At present most of the lightships were approached by about six other vessels a day; but if it became known that electrical communication could be had with the shore, the number would, no doubt, soon increase to twenty or more a day. The danger would then arise of the running down of the lightships themselves, thereby leaving dangerous shores without warning to mariners. Experiments were being made by Lloyd's with a view to the establishment of improved communication between these vessels and lighthouses and the shore without any direct metallic contact.

Licenses for Electricians in New England.—The electricians of New England have taken an important step in forming an "Electric Exchange." The object of the exchange is stated by the rules to be the "general promotion of electrical business, and especially in the direction of securing perfection in electric light and electric power installations, and in harmonising and adjusting, as far as possible, all differences which may arise between various electrical interests;" but more interesting and important is the determination to issue licenses to electricians. There are five classes of licenses:—(1) To persons qualified to install and operate arc, incandescent, or power plants; (2 and 3) To persons qualified to install and operate any two or one, respectively, of the foregoing; (4) To persons competent to operate electric machinery; (5) To persons competent to do electric wiring. Before obtaining a license (of any class) candidates must pass an examination set by three examiners selected by the committee of the exchange. On satisfying the examiners, a license bearing the seal of the exchange and signed by an officer of the Boston Tariff Association, or the New England Insurance Exchange, will be issued. Licenses are renewable annually, and even a holder of a first-class license may be called upon to undergo further examination in order to show that his knowledge is

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keeping pace with the march of electrical science. The appearance of the insurance associations in the matter is explained by the facts that the exchange has for one of its objects to act as an intermediary between the electricians and the insurers, and that the latter have agreed to reduce their rates for buildings fitted by licensees of the former. The exchange invites "everyone actually engaged in manufacturing or installing electric light or electric-power apparatus, or in operating commercially an electric light or power plant" to become members.

Anniversary Celebrations by Spanish Telegraphists.—The 22nd of April last was the thirty-third anniversary of the inauguration of the first telegraph line in Spain. The event was celebrated by banquets in most of the important centres, Madrid alone being conspicuous, according to a local paper, for the absence of any commemoration. In Barcelona a banquet was held in the Hotel Miramar, under the presidency of Señor Savall, the chief officer of the telegraph service in that district. Señor Savall expressed his regret that the financial position of the department did not permit of a more liberal acknowledgment of the services of the subordinate officers. Señor Saavedra gave an interesting historical survey of the telegraph in Spain, and he was followed by Mr. Browne, the representative in Barcelona of the Direct Spanish Telegraph Company. Mr. Browne's speech had special reference to the *employés* of foreign companies and administrations, and he commented upon the fact that by the introduction of the telegraph national frontiers had in a sense been obliterated. The observations of the chairman respecting remuneration and promotion were referred to by several speakers, one of whom indicated, as an example of the defective organisation, the case of two officers present, both in the same class, although one had seen four years' service only and the other 25 years' service. Reference was also made to the anticipated pressure of work consequent upon the opening of the Exhibition this year as a reason for some additional monetary consideration. The chairman promised to exert himself to that end, but was unable to hold out much hope, owing to the deficient state of the finances. With reference to the chairman's allusions to the financial conditions of the Spanish telegraph service, we may refer our readers to a "Note" in *The Electrician* of January 20th last, p. 257, under the head of "Spanish Telegraph Statistics."

Technical Instruction for South-west London.—Mr. Anstie, Q.C., received at the Charity Commissioners' offices, Whitehall, on Monday, a large deputation from Chelsea, Pimlico, St. George's, Hanover-square, and Fulham, who asked for a grant of money from the City Parochial Funds in order to establish a technical institution in the south-west of London. The deputation included Lord Monkswell, Sir C. Dilke, Col. Howard Vincent, M.P., Mr. Whitmore, M.P., Hon. S. Holland, Sir A. Hayter, Mr. Antrobus, the Rev. F. Relton, the Rev. G. Blunt (rector of Chelsea), and the Rev. Prebendary Eyton (rector of Upper Chelsea). The Rev. F. Relton, in introducing the subject, said Earl Cadogan had offered a site upon which to erect the institution, and had left it to them to choose a suitable one. The site would cost £2,500, but Earl Cadogan had said that if they acquired the leasehold he would give them the freehold. There had been for about 20 years a small technical institution, which had resulted in the formation of Onslow College, the success of which had been very great. They were anxious that in the south-west of London there should be a technical institution such as was proposed for the north of London, the south of London, and the east of London. He could assure the Commissioners that there was a great deal of poverty in the south-west of London, and he might add that there was a large number of artisan dwellings in the locality, a fact which fully entitled them to a share of the funds. Mr. Antrobus, speaking on behalf of St. George's, Hanover-square, said the great advantage to be derived from the establishment of such an institution in the south-west of London was generally recognised. Mr. Anstie, in reply, said he could not give the deputation any definite answer; but if the locality could raise the sum of £50,000 and could come to some agreement with Onslow College, the Commissioners would give the proposal their consideration.

Execution by Electricity.—We reproduce the following article from the *Lancet* :—"The authorities of New York have come to the decision that henceforth all criminals sent to death for capital offences in their State shall be killed by the electric shock. The practice, once determined on by one State, is sure to be followed by other States; and, if the first experiments be considered successful, we may soon expect to see the plan widely, if not universally, extended. The idea which is at the bottom of this change is due, first to the popular belief that everything that is now to be done with rapidity must be done by means of electricity; and, secondly, that death by electricity is absolutely painless. That the electric shock can be applied to man in such a manner as to destroy life instantly and painlessly is beyond dispute. The shock can be applied at such tension as to rupture the veins, and even the right side of the heart. But in order to apply it with absolute precision it must be used in the most certain way, since it may seem to cause the death and yet may not kill. One of the most striking examples of catalepsy in our time was caused by a lightning stroke, which is the same as the shock; and the subject of the shock was so thoroughly mistaken for one dead that he was laid out for dead, and heard the sound of his own passing bell; yet he recovered, and lived many years afterwards to recount the strange experience. In experiments on the lower animals, it has also been observed that a shock sufficient to produce such complete prostration as seemed fatal was not so. The greatest care, therefore, must be taken, if the electric shock be used for destroying the lives of criminals, that the criminals be not buried alive after an assumed death. In the further consideration of this question the policy of the proceeding as well as the humanity of it requires to be taken into account. If the execution of criminals is to be maintained it must carry with it some degree of terror. If it does not, then, even in the eyes of those who are in favour of it, it will be looked upon as a solemn and cruel farce. It would be so, nothing more, nothing less. The argument for the Act is that 'it is a terror to evildoers'; but, as we once before pointed out, if the dread of suffering is to be taken away, if the transit from life to death is to be made more easy than the common modes by disease, then in some cases an actual premium will be put upon crime. In plain words, if the death penalty be right there is nothing whatever in the present system that is one whit too severe. Why, then, should the present plan be interfered with? Why should the gallows be made to lose its indefinable terrors? A new mode of executing will be sure to bring a new sentiment in respect to execution, and perhaps in respect to the executed. 'The man was *electrified* for the murder.' Will that do? At a moment when the question of the judicial act is itself in the balance, is it good policy to open a new era in the method of carrying into effect a tragedy for which our successors are sure to stamp us as barbarous, and against which many of the wisest and most cultivated of our time are raising an emphatic protest whenever the opportunity occurs?"

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CONTINUOUS-CURRENT TRANSFORMATION.

BY R. PERCY SELLON.

(Continued from page 624.)

ARTICLE II.

In a previous article, published in *The Electrician* of April 13th, the merits and demerits of a system of electrical distribution based upon the employment of continuous-current transformers was briefly glanced at.

In the present article it is proposed to survey the past history of the continuous-current transformer, referring to publications and patents which have appeared upon the subject.

The first suggestion to utilise continuous currents for the purposes of transformation, so far as the writer has been able to trace, appeared in the *Comptes Rendus* de l'Académie des Sciences of Paris for the 23rd of November, 1874. M. Alfred Niaudet, in a pamphlet published in 1875, awards the credit of the invention to M. Gramme, father of the modern dynamo machine.

The following abstract from this pamphlet will be of interest:—

"M. Gramme, in the *Comptes Rendus* of the 23rd Nov., 1874, has shown that his apparatus can be used for transforming electricity. He employs for this purpose an armature wound with two circuits, one of fine and the other of thick wire, placed between the poles of a magnet. If the current of two Bunsen elements be sent through the thick wire the armature will begin to revolve, and as the result of this motion there will be produced in the fine wire coils a current of electricity, in the same manner as in an ordinary 'Gramme' machine. In this instance the secondary current has a higher electromotive force than the primary one, the ratio in the machine experimented upon being 8 to 1. It will be seen that we are dealing here with the transformation of electricity, and the change in the tension is analogous to that produced in the Ruhmkorff coil. With such an apparatus the current of two Bunsen cells could be transformed and made equivalent to a small current from 16 Bunsen or 30 Daniell cells, and employed in telegraphy. It is important to notice that the apparatus of Gramme admits not only of the transformation of low-tension currents into those of high-tension currents, but also of the reverse of this, viz., the transformation of a current of high tension into one of low tension. There is no gain of power by this transformation, because the increase in tension corresponds to a loss in volume of current, and *vice versâ*."

Here we find distinctly set forth the principle of transformation by means of continuous currents, and it is interesting as affording to those who regard continuous-current conversion as a creation of yesterday an apt illustration of the adage that "there is nothing new under the sun."

At this point, however, the matter appears to have dropped for some years, until we find it resuscitated, and (it goes without saying) patented, by the indefatigable genius of Menlo Park, followed, at no remote period, by that second parent of modern electric lighting, Lane-Fox, both of whom conceived the idea of a system of distribution based upon the use of these apparatus.

Just previously to the above, Gravier, in a patent bearing date 13th March, 1882, No. 1,211, describes "an inductor or transformer of currents by which a given current may be converted into a continuous or an alternating current either in tension or quantity." This consists of a Gramme ring, wound with two series of insulated wire coils, each series connected to a separate commutator. The collecting brushes upon the two commutators are placed at right angles to each other.

The passage of a current through the primary coils produces consequent poles in the ring; and, upon rotation being imparted, "the successive passages of the secondary coils over the consequent poles of the annular magnet will induce currents of electricity in those coils, which may be collected and utilised in any desired manner, or in lieu of revolving the ring the brushes alone may be revolved."

So far the apparatus is not a rotary transformer as ordinarily understood; under a modified arrangement, however, "a mass of iron is placed in front of the consequent poles of the magnet," so that when "a current of electricity is sent into the primary circuit (the brushes being suitably placed to obtain the effect desired) the ring will turn on its axis in order to obtain a position of stable equilibrium in front of the mass of iron. From the very fact of this rotation a current will be induced in the coils of the secondary circuit." The revolution is evidently intended here to be produced through the presence of induced poles in the "mass of iron" resulting from the consequent poles produced in the ring by the primary coils; the mass of iron thus virtually becomes an external exciting field.

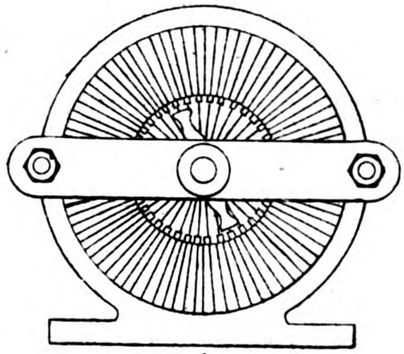

Fig. I.

Fig. 1 shows this device, the "mass of iron" being represented by the block placed horizontally across the ring. The claim is for "the arrangements of machinery above described, in which a ring is used to carry inductor coils and overlying induced coils for the purpose of producing electric currents."

Five months later, in a patent, No. 3,752, of August, 1882, Edison describes an invention which has for its object "the production of efficient and economical means for dividing an electric current of high electromotive force or tension into a number of currents of lower electromotive force or tension, and for making all the lamps, motors, or other translating devices operated by the currents of lower tension independent

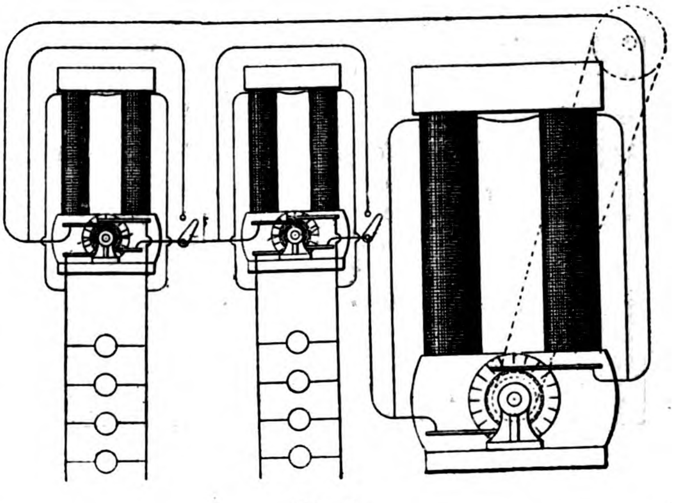

FIG. 2.

of each other. Such an arrangement enables a great saving to be effected in conductors, since a high-tension current can be used from the point of generation to near the point of generation, and the translating devices can be made independent by a multiple-arc arrangement."

After proceeding to describe how one method of doing this consists in interposing into a series circuit counter electromotive forces such as motors or secondary batteries, he states that by an alternative method it may be effected by introducing "combined electro-dynamic motors and dynamo-electric generators"

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into the circuit. "Each machine has a cylindrical or annular armature core, wound with two sets of continuous coils, connected to two independent bar commutators." The primary armature coils are all in series, while low-tension multiple arc supply is obtained from the secondary armature coils. The field magnets, which are common to both sets of armature coils, are wound on a shunt with the supply coils, and the machines are thrown into and out of circuit by opening or closing a short-circuiting switch across the terminals of the primary.

Fig. 2 shows the arrangement.

A claim is made for "the combination with one or more dynamo or magneto electric machines supplying a main circuit with a current of high tension, of two or more combined electro-dynamic motors and dynamo-electric generators arranged in series as motors in such main circuit, and supplying as generators independent circuits, means for cutting out of the main circuit any one of such combined motors and generators, and multiple arc circuits from the said independent circuits, having translating devices arranged therein, and including field coils of such combined motors and generators, all substantially as hereinbefore described."

Under a second patent, taken out twelve days later (August 17, 1882), numbered 3,949, the same inventor describes another means of continuous-current conversion, consisting in the employment of "induction apparatus constructed as hereinafter described," virtually stationary transformers, wound with primary and secondary coils, "located between the main circuit and the translating devices, and transforming a continuous current of high tension into a continuous current of low tension."

Two commutators—one in connection with either set of coils—are fixed upon a common shaft and "revolved by any suitable means, as, for example, by an electro motor or a spring or weight actuated by mechanism." Upon the revolution of the common shaft, rapid reversals of polarity are produced in the primary coils, thus inducing currents alternating in direction in the secondary coils. These secondary currents are, however, commutated synchronously with the primary currents, so that a continuous current is produced in the secondary supply circuit.

A claim is made for conducing the tension of a continuous current for use in a "resumption circuit having translating

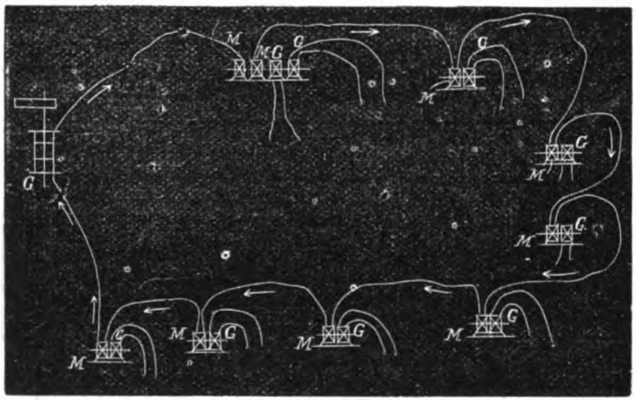

Fig. 3.

devices arranged in multiple arc, below that of the main circuit, by means of induction apparatus placed between the said circuits, and consisting of intermediate double-wound magnetic cores, and commutators for simultaneously changing or advancing the connections of the circuits with the winding of such cores, all substantially as hereinbefore described with reference to the accompanying drawings."

This is followed by a patent, No. 3,692, dated July, 1883, of St. George Lane-Fox.

This sets out that "in dealing with distribution of electricity on a large scale, the question of transmission from localities where motive power is cheap is of very great importance. To transmit electricity over long distances it is essential that high pressure or high tension be used, so as to keep down the cost of conductors, and to reduce the loss in such conductors; but for well-known reasons it is best not to distribute electricity at high tension. I have therefore devised the following system, to combine the advantages of high tension for long-distance transmission with the advantage of a lower tension for distributing in centres of supply."

Lane-Fox then proceeds to describe a system based upon the use of rotary transformers, and adds that "secondary batteries may be used to keep the electromotive force constant and act as reservoirs."

Fig. 3 illustrates the drawing attached to the specification. M represents the motor, G the generator circuits.

The claim is for "the system of electrical distribution hereinbefore described."

(To be continued.)

NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

(Continued from page 654.)

If a current traversing an inductive circuit under a periodic impressed electromotive force is made to pass through another circuit which acts electro-dynamically upon a movable circuit conveying another current proportional in strength to, and agreeing in phase with the periodic variation of potential difference at the terminals of the inductive circuit, such an arrangement will, if it can be realised, afford a means for obtaining a numerical measure of the power taken up in the inductive circuit.

An electro-dynamometer having its fixed coil composed of thick wire and its movable coil of fine wire, each circuit being independent, is most usually called a *wattmeter*. The examination of the circumstances under which the wattmeter can and cannot be used to measure the power expended in a circuit subject to simple periodic electromotive force, leads to some very interesting questions.

If the thick and thin wire coils of a wattmeter are traversed by two independent steady unidirectional currents the force on the movable coil is at any instant proportional to the product of the strengths of these two currents. If each of these cur-

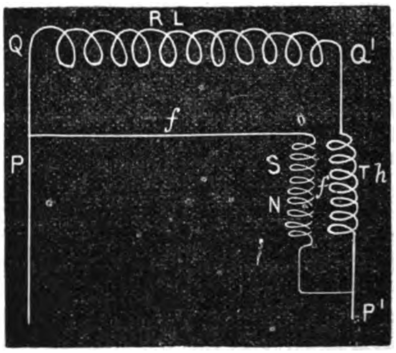

Fig. 35

rents are simple periodic currents the force varies with the product of the instantaneous values, and the compound curve formed by taking as ordinates the products of the corresponding values of these separate current strengths at each instant is itself a simple periodic curve, provided that the two component currents have constant amplitudes, equal period, and fixed difference of phase. Let a wattmeter be supposed to be joined up to an inductive circuit (*see* Fig. 35); let R and L be the resistance and inductance of this inductive circuit between the points Q Q'; let the thick wire coil *Th* of the wattmeter be joined in series with this inductive resistance, and let the fine wire coil *f* of the wattmeter of resist-

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ance S and inductance N be joined to the points P P′; let the thick wire coil be of negligible resistance and inductance in comparison with the circuit Q Q′. If a simple periodic electromotive force operate on the double circuit between the points P and P′ we shall have a current flowing in R and S; it is required to calculate at any instant the currents in R and S respectively. Consider simply a divided circuit (Fig. 36) in which R and S are the branches; let x be the current at any instant in R and y that in S, and let i be the strength of the current in that part of the circuit just before it divides; in other words, i is the main current which is divided into x in the induction resistance, and y in the fine wire coil of the voltmeter. Let e be the potential difference between the points P P′ at the same instant, and let X, Y, I, and E be the maximum values of all these quantities respectively. We assume that i is a simple periodic function of I, and we then write $i = \mathrm{I} \sin p t$, where $p = 2\pi n$, n being the

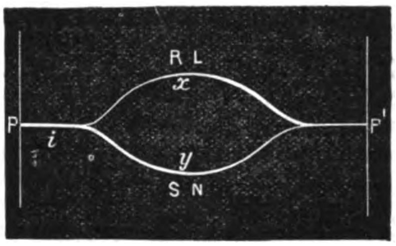

Fig. 36.

frequency. Applying the fundamental equation to each circuit, we see that

$$\mathrm{L}\frac{dx}{dt} + \mathrm{R}x = e;$$

also

$$\mathrm{N}\frac{dy}{dt} + \mathrm{S}y = e.$$

Accordingly,

$$\mathrm{L}\frac{dx}{dt} + \mathrm{R}x = \mathrm{N}\frac{dy}{dt} + \mathrm{S}y;$$

but by the principle of continuity

$$i = x + y$$

always, since there can be no accumulation of electricity at P or P′; hence

$$x = i - y,$$

and, hence,

$$\mathrm{L}\frac{d(i-y)}{dt} + \mathrm{R}(i-y) = \mathrm{N}\frac{dy}{dt} + \mathrm{S}y,$$

or

$$\mathrm{L}\frac{di}{dt} + \mathrm{R}i = (\mathrm{L}+\mathrm{N})\frac{dy}{dt} + (\mathrm{R}+\mathrm{S})y;$$

but

$$\frac{di}{dt} = \mathrm{I}p\cos pt,$$

and

$$i = \mathrm{I}\sin pt.$$

$$(\mathrm{L}+\mathrm{N})\frac{dy}{dt} + (\mathrm{R}+\mathrm{S})y = \mathrm{I}\,\mathrm{L}p\cos pt + \mathrm{I}\,\mathrm{R}\sin pt,$$

or

$$\frac{dy}{dt} + \frac{\mathrm{R}+\mathrm{S}}{\mathrm{L}+\mathrm{N}}y = \frac{\mathrm{L}p\mathrm{I}}{\mathrm{L}+\mathrm{N}}\cos pt + \frac{\mathrm{R}\,\mathrm{I}}{\mathrm{L}+\mathrm{N}}\sin pt.$$

This differential equation is of the type

$$\frac{dy}{dt} + \mathrm{P}y = \mathrm{Q},$$

where Q is a function of t. The solution of this will be found in "Boole's Differential Equations," p. 38, and it is

$$y = e^{-\mathrm{P}t}\left(\int \mathrm{Q}e^{\mathrm{P}t}dt + \text{const}\right),$$

e being here the base of Nap. logs. and not impressed E.M.F.

In the case before us

$$\mathrm{P} = \frac{\mathrm{R}+\mathrm{S}}{\mathrm{L}+\mathrm{N}},$$

and

$$\mathrm{Q} = \frac{\mathrm{R}\,\mathrm{I}}{\mathrm{L}+\mathrm{N}}\sin pt + \frac{\mathrm{L}p\mathrm{I}}{\mathrm{L}+\mathrm{N}}\cos pt.$$

The integral of $e^{\mathrm{P}t}\sin pt$ and $e^{\mathrm{P}t}\cos pt$ are required. They are as follows:—

$$\int e^{\mathrm{P}t}\sin pt = \frac{e^{\mathrm{P}t}(\mathrm{P}\sin pt - p\cos pt)}{\mathrm{P}^2+p^2},$$

and

$$\int e^{\mathrm{P}t}\cos pt = \frac{e^{\mathrm{P}t}(\mathrm{P}\cos pt + p\sin pt)}{\mathrm{P}^2+p^2};$$

hence it follows that

$$\int e^{\mathrm{P}t}\mathrm{Q}\,dt = \int e^{\mathrm{P}t}\frac{\mathrm{R}\,\mathrm{I}}{\mathrm{L}+\mathrm{N}}\sin pt + \int e^{\mathrm{P}t}\frac{\mathrm{L}p\mathrm{I}}{\mathrm{L}+\mathrm{N}}\cos pt$$

$$= \frac{\mathrm{R}\,\mathrm{I}}{\mathrm{L}+\mathrm{N}}e^{\mathrm{P}t}\frac{(\mathrm{P}\sin pt - p\cos pt)}{\mathrm{P}^2+p^2} + \frac{\mathrm{L}p\mathrm{I}}{\mathrm{L}+\mathrm{N}}\frac{e^{\mathrm{P}t}(\mathrm{P}\cos pt + p\sin pt)}{\mathrm{P}^2+p^2};$$

and

$$\mathrm{P}^2 + p^2 = \frac{(\mathrm{R}+\mathrm{S})^2 + (\mathrm{L}+\mathrm{N})^2p^2}{(\mathrm{L}+\mathrm{N})^2}.$$

Therefore we have by substitution

$$y = \frac{\mathrm{I}}{(\mathrm{R}+\mathrm{S})^2 + (\mathrm{L}+\mathrm{N})^2p^2}\left\{\begin{array}{l}\mathrm{R}(\mathrm{R}+\mathrm{S}) + \mathrm{L}(\mathrm{L}+\mathrm{N})p^2\sin pt \\ +\overline{\mathrm{R}+\mathrm{S}}\,\mathrm{L}p - \mathrm{R}\,\overline{\mathrm{L}+\mathrm{N}}\,p\cos pt\end{array}\right\},$$

or

$$y = \frac{\mathrm{I}}{(\mathrm{R}+\mathrm{S})^2 + (\mathrm{L}+\mathrm{N})^2p^2}\left\{\begin{array}{l}(\mathrm{R}^2 + p^2\mathrm{L}^2 + \mathrm{RS} + \mathrm{LN}p^2)\sin pt \\ \qquad + (\mathrm{S}\,\mathrm{L}p - \mathrm{R}\,\mathrm{N}p)\cos pt\end{array}\right\}.$$

Since the original equations are symmetrical in x and y, R and S, L and N, the value for x is given by changing R to S and L to N in the equation for y.

This equation for y gives us the strength of the current in the fine wire coil, and it shows us that the phase of the currents x and y in the branch circuits differs from that of the main current i by an amount which depends on L, N, R and S. In order to exhibit this in a simple form we may direct attention to a simple trigonometrical transformation.

Lemma.—The function $\mathrm{A}\sin\theta + \mathrm{B}\cos\theta$, where A and B are constants, may otherwise be written

$$\sqrt{\mathrm{A}^2+\mathrm{B}^2}\sin(\theta+\phi),$$

where

$$\tan\phi = \frac{\mathrm{B}}{\mathrm{A}}.$$

Draw any rectangle (*see* Fig. 37) O P, O Q, and draw a pair of rectangular axes, O X, O Y, through O. Project the

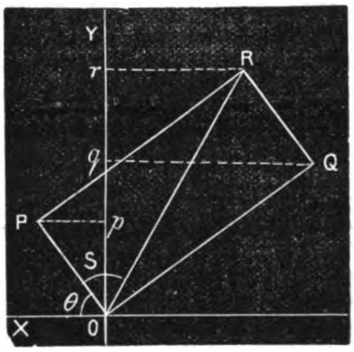

Fig. 57.

points Q, R, P on O Y. Then by geometry if $\mathrm{POX} = \theta$, and $\mathrm{POR} = \phi$,

$$\mathrm{O}r = \mathrm{O}p + \mathrm{O}q,$$
$$= \mathrm{OP}\sin\theta + \mathrm{OQ}\cos\theta,$$
$$= \mathrm{OR}\sin\mathrm{ROX} = \mathrm{OR}\sin(\theta+\phi);$$

hence

$$\mathrm{OP}\sin\theta + \mathrm{OQ}\cos\theta = \mathrm{OR}\sin(\theta+\phi)$$
$$= \sqrt{\mathrm{OP}^2+\mathrm{OQ}^2}\sin(\theta+\phi).$$

But

$$\tan\theta = \frac{\mathrm{OQ}}{\mathrm{OP}};$$

hence

$$\mathrm{A}\sin\theta + \mathrm{B}\cos\theta = \sqrt{\mathrm{A}^2+\mathrm{B}^2}\sin(\theta+\phi)$$

where

$$\tan\theta = \frac{\mathrm{B}}{\mathrm{A}}.$$

Returning then to the equation for y, the coefficients of $\sin pt$ and $\cos pt$ in the equation are respectively $\mathrm{R}\,\overline{\mathrm{R}+\mathrm{S}} + \mathrm{L}\,\overline{\mathrm{L}+\mathrm{N}}\,p^2$, which represents the A, and $(\mathrm{R}+\mathrm{S})\mathrm{L}p - \mathrm{R}$

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$(L+N)p$, which represents the B, in the above. Squaring each of these expressions, and adding the results, we obtain as a result

$$\{(R+S)^2+(L+N)^2p^2\}\ (R^2+p^2L^2);$$

hence we finally arrive by substitution at the equation for y

$$y=\frac{I\sqrt{R^2+p^2L^2}}{\sqrt{(R+S)^2+p^2(L+N)^2}}\sin(pt+\theta).$$

where $$\tan\theta=\frac{B}{A}=\frac{(R+S)Lp-R(L+N)p}{R(R+S)+L(L+N)p^2},$$

or, $$\tan\theta=\frac{(SL-RN)p}{R(R+S)+L(L+N)p^2}.$$

In this form the equation for y shows us that the phase of y is *ahead* of that of i, or that the main current lags behind the current in the branch S, provided that S L is greater than R N; and since the expression for the current x is perfectly symmetrical, we can write it down at once, and it is

$$x=\frac{I\sqrt{S^2+p^2N^2}}{\sqrt{(R+S)^2+p^2(L+N)^2}}\sin(pt+\theta')$$

where $$\tan\theta'=\frac{(RN-SL)p}{S(R+S)+N(L+N)p^2},$$

and it is obvious that if S L is greater than R N, $\tan\theta$ is positive, and $\tan\theta'$ is negative.

If S L = R N, then there is no lag, and the branch currents x and y agree in phase with the main current i.

The general result is, therefore, this—when an impressed electromotive force acts on a circuit which branches into two, having each self but no mutual induction, the main current lags behind the impressed E.M.F. in phase, and the two branch currents respectively *lag behind* and are *pressed ahead* of the phase of the main current.

The question then arises, under what circumstances does the branch current which is in advance in phase of the main current get so much ahead that it comes into consonance with the phase of the impressed E.M.F.?

To settle this question, we shall have to discuss briefly the question of the compound impedance of branch circuits.

(To be continued.)

JUVENILE LECTURES.

THE APPLICATION OF ELECTRICITY TO LIGHTING AND WORKING.*

BY W. H. PREECE, F.R.S.

Lecture I. (continued from page 693.)

We are to-night connected in this room with the Grosvenor Gallery in Bond street. The Grosvenor Gallery has a central station where a very large dynamo is at work, from which electricity is supplied to different parts of London; many thousand lamps are fed in a great many clubs, theatres, and private houses; they are all lit up by the currents generated underneath the Grosvenor Gallery. The Grosvenor Gallery Company, through their engineer, Mr. Ferranti, have very kindly undertaken to supply us to-night with a current. The current is supposed to be a very dangerous one; in reality it is not; there is no electric current that has ever been produced that is one-tenth as dangerous as a steam boiler, and all these currents, however immense they may be, are very simply controlled, and very easily brought within the region of safety. There is no doubt that with the apparatus that is now being handled in this room, if anybody were deliberately to put one wire in his mouth, and the other in his hand, he would have the funeral service performed over him in two or three days, but those who know what they are about no more handle electric light wires carelessly than they put their hands in a furnace or their noses in boiling water. We acquire experience by practice, and we know by this time pretty well how to deal with electric currents. Now you see in the lower arrangement there that safety catches are being put in, which render any accident quite impossible. Passing through each of those boxes there is what is called a "cut-out" safety fuse, or safety valve, and should, from any accident, anything go wrong in this theatre, or in any way with the system outside the theatre, the safety fuses would burst, and would so remove all danger from inside. The switch has now been turned, and by it the current from the Grosvenor Gallery has been brought within our reach. You will see that between what appears to you as the top carbon (but which is in reality the bottom carbon of the two) and the bottom one there is playing, apparently, a shower of minute fragments of something, but which are in reality innumerable minute flashes of lightning; there is a constant uninterrupted shower of electric shocks passing that produce that intense brilliancy, and that very bright appearance. There is intense commotion, a terrible surging about of matter in a molten condition. Well that arc that you see is produced by the currents from the Grosvenor Gallery. They are alternating currents of electricity; currents that are constantly and suddenly circulating backwards and forwards. The arc that we have at this other end of the room is a direct-current one, and it is now projected on to another sheet of paper, where you see a different form of arc altogether. This arc is produced by the direct current from a battery. You will see the form is quite different from that in the alternate-current arc. You heard a peculiar hissing sound just now; that is a peculiar phenomenon in arc lamps that has attracted a good deal of attention from physicists, but nobody has yet arrived at a satisfactory conclusion as to the cause. The lamp sometimes sings and sometimes hisses, and while thus behaving it produces an intense and variable inverse electromotive force that has to be overcome before the current can produce a steady and silent arc. You will notice in the upper carbon of this form of lamp a kind of cup, or "crater." The lower carbon forms a kind of point—a raised surface, and between the two there is on the projection that which appears as a glow, but which in reality has very intense heat, reaching, as I told you, a temperature of 8,500° F. In these two projections you have, I think, within my experience for the first time, shown in public an alternate-current arc and a direct-current arc at the same time, so that you are really able to see what I do not think most people have seen before.

There are a great many different arc lamps. I have not time to bring before you all the various lamps that I might have secured for your inspection. There is the Brush lamp, that for a long time lit up the streets of our City, and I sincerely hope very soon is going to light up the City again. There was the Jablochkoff lamp, that lighted up our Thames Embankment, and which can be seen on going down the Strand, at the Tivoli Restaurant, not far from here. The offices of the *Daily Telegraph*, in Fleet-street, and many other places, are lighted up by different lamps, many of them excellent. Our experience of the last two or three years at the exhibitions has taught us that there are a great many different kinds of arc lamps, but all these arc lamps are lamps so constructed that they cause the pair of carbons to be fed to be kept together as they consume, at the same rate as they do consume. The mechanism is of great delicacy, it acts with great promptitude, and the one that we have here to-night is one of the last and one of the best; it is known as the Brockie Pell lamp. The lamp now at work is a Brockie-Pell; it feeds with great rapidity, with great convenience, and is one of the steadiest lamps we have.

There are objections to the arc light; it is extremely dazzling and irritating to the eye. Although the arc lamps we have here to-night are of the very best of their kind, and are certainly almost steady, still they have little irregularities in their action, and, worst of all, they throw intense shadows. The light from them is not very well diffused; still the light is very brilliant, and it raises the envy of a good many people. For instance, the Brush Company were once establishing a light in

* A course of three Lectures delivered before the Society of Arts on January 4th, 11th and 18th.

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the neighbourhood of Cork, and an Irish farmer was remarkably struck by the appearance and the steadiness of the light, so he came to the engineer in charge and asked him, as a great favour, if he could kindly tell him where he got his oil from.

I must now go from this to the next branch, the glow lamp. For this lamp we do not use platinum, but we use carbon, so fine that although I have probably one hundred or more in my hand, they feel no heavier than a feather. These extremely fine filaments of carbon are made, with very great care, from cotton. I cannot show you the whole operation of making carbons and some of the preliminary operations connected with the making of the lamp; but owing to the kindness of the Anglo-American Brush Company, their manager, Mr. Sillar, is here to-night, and we shall have the pleasure of seeing how the whole operation of the manufacture of one of these glow lamps such as we have above us now is carried out. The carbons have already been formed, but the first process is that the cotton fibre is carefully tied and wrapped around pieces of carbon, as you see. It is then placed in a furnace and carbonised. After being thus prepared, a glass tube of special quality, selected for the purpose, is used to form the glass globe. Mr. Donaldson will take a piece of the glass tube before you, and will blow it into the shape similar to the lamp I hold, which is of the very familiar pear-like form. The carbon filament with then be fixed in the glass bulb, the latter will be exhausted and sealed, and the whole process be passed through before your eyes. I must first of all show you why it is necessary to take all this care. We have in front of the board one of these carbon filaments suspended, and we will now pass a current through it, and the carbon filament is raised to incandescence; it combines with the oxygen of the air, it is at once consumed, and, as you saw, we only had a light for a few seconds. Now, in order to make that light permanent, it is necessary to enclose the carbon filament in a glass globe, and to exhaust from that glass globe all the air, or as much of it as possible, and then, instead of having a life of a few seconds, the life of a lamp frequently continues for 4,000 hours or 5,000 hours. The first process, as I said, in making an incandescent lamp, after the carbon filament has been prepared, is that of blowing a glass bulb. The blow pipe has now been put on, and the intense heat of the Bunsen burner raises the glass to incandescence, to a soft, plastic condition, so plastic that the manipulator can do with it just whatever he likes. Having got the glass to this particular shape, the filament will be placed inside it, first of all mounting the filament, which is an operation requiring a great deal of care and great skill in handling. It is an extremely pretty operation, and I beg to call your attention to it. The carbon is fixed inside a fine spiral of platinum, which is at the same time subjected to an intense current which decomposes the oil or the hydrocarbon in which it is placed, the carbon deposits on the carbon filament, and cements it to the platinum spiral. That is called mounting the filament. When that is done, the filament is fixed in the glass globe, and the platinum and glass are fused together. The brilliance of the platinum can be seen during this operation, and it is very pretty. I do not know how it would have been possible for us to have glow lamps if it had not been for the fact that the coefficients or rates of expansion of platinum and glass are practically exactly the same, and the result is that when the platinum and glass are combined together, as they are in a glow lamp, the two contract and expand at the same rate, and the result is there is no leakage; if there had been leakage through the glass it would have been quite impossible to have made a glow lamp. The success of a glow lamp depends upon the vacuum produced, and the next process is to cement the lamp so far to a vacuum tube connected to a mercurial air pump. The one before you is Mr. Lane-Fox's. It would have been also impossible to have produced these beautiful glow lamps without the mercurial air pump, so that the success of electric lighting and its perfection depend upon, first, the similarity of expansion of glass and platinum; and, secondly, upon our power of producing a vacuum. As it takes ten minutes or a quarter of an hour to carry out the process of exhaustion, I will proceed with other portions of my subject, and presently, when the time is ready, Mr. Sillar will inform me, and we will light up the lamp that has been made before you this evening, and, I hope, with success. The operation we have just seen is one that has been just as interesting to me as it has been to you. There are very few who are permitted to see this operation. We once had it before in this hall, when General Webber read a paper on glow-lamps, but with that exception I am not aware that the manufacture of glow-lamps has ever been shown in public before. It is most wonderful to watch the marvellous way in which glass can be twisted and turned to our ways and to our wants; and the skill with which the blower is able to manipulate glass in its plastic condition, and to shape it in any form he likes, is an operation which never ceases to excite one's wonderment. The form of lamp that is being made before us is of the ordinary size that we see used generally, but there are a great many different sizes of glow-lamps. For instance, here is a very small lamp; above me you will see, if I may call the small one a dwarf, there is a giant glow-lamp. It is a lamp invented by the Hon. Charles Parsons; it is made by the Sunbeam Lamp Company, of Gateshead, and is called the Sunbeam Lamp; it has the same proportion to an ordinary lamp that an ostrich egg has to a hen's egg, and the light from it is of equally large proportion, as you see now the current has been turned on to it. It gives a light of 400 candles, but it is rather too brilliant, I see by your faces, and we will go back to our old friends of the ordinary size. There are also above us lamps of various sizes; there is a five-candle, ten-candle, sixteen-candle, twenty-candle, and a hundred-candle lamp. Here also are a fifty-candle Swan lamp, a sixteen-candle Swan, and an eight-candle Swan lamp. These are the ordinary sixteen-candle lamps; these are being burned from the Grosvenor Gallery. Here is a miner's lamp which is supplied with a current by the Schanschieff battery, the same as I showed you at first; the peculiarity of this arrangement is that when the battery is turned upside down the light goes off, the zincs and carbons occupy one-half of the cell, and the solution the other half, the zincs and carbons being at the bottom, and the battery is not excited unless contact is made with the carbons and zinc. Such a battery as this will maintain its lamp for 12 or 13 hours. There are several forms of the Schanschieff battery. Here is a portable form, and lamp connected with it by a flexible wire, which can be used when travelling; or in the night, when you want to know the time, you can have a lamp and battery like this by your bedside, and you can turn it upside down, and produce a light, see the hour, and turn the battery back.

These glow-lamps are used for different purposes and ways. They may be used with care, they may be used recklessly; their duration depends a good deal upon the care with which they are used. A practised eye, one who is accustomed to deal with electric lamps, can tell at a glance when the lamp is raised to a proper incandescence; but there is a point in all lamps that is a sign of danger, and indicates "breakers (or breakage) ahead." Whenever in an electric light installation a glow-lamp begins to show a blue effect, then breakers are ahead; the current must be reduced or other steps taken. I want to show you this blue effect, which is extremely pretty, and I want you to see the gradual stages through which a lamp passes, from long life to death, or rather to a very short and merry life. We can make the life of a lamp just exactly what we like; we can make a lamp last a minute, or we can make it last a hundred years, and the number of years of its duration is simply dependent upon the current employed. I have here a glow-lamp, and I pass a current through it. There is no blue effect at present; the current is increased, and the carbon filament is raised to a high state of incandescence. In such a state it would not last for a long time, not more than ten minutes or a quarter of an hour; but it does not show the blue effect yet. On further increasing the current the blue effect appears, though I doubt whether it is visible to many of the audience; a little more current is put on, and the blue effect is very marked, the globe itself looks very brilliant, and, there, the current has been increased until the filament has parted.

It is always better when making an observation or expe-

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riment to know what you are going to see, so that you can direct your attention to exactly what is being done or to what you want to know. If I put another lamp through the same experiment you will be better able to understand this blue effect, and see just that point where the lamp is about to give out. The current is now on, and is being gradually increased; the lamp is now intensely blue, and—there, it has gone in the same way exactly as the other one did. The way in which lamps burst is sometimes very beautiful; they disintegrate, they seem to volatilise, and the substance of the lamp is projected with great force against the side of the globe. On the table there are several beautiful specimens showing this effect.

The glow-lamp in process of manufacture before you is now being unsealed from the pump; it is now exhausted, and we will pass a current through it so as to raise it to incandescence. The current is now on, and you see the lamp burns with full brilliancy. The next experiment is rather a cruel one, because it is wilful destruction. I will not destroy the lamp that has just been made before us, for I will keep it as a momento of this evening. I want to show the safety of the electric lamp. Many people imagine that there is a great deal of danger about it. I will take a handkerchief, and in it place a lighted lamp, when, on the globe being broken, the carbon filament instantly goes out, and there is no damage to the handkerchief, or the slightest appearance of scorching or heating upon it. On breaking that lamp you hear a report. That is due to the vacuum, which, on sudden rupture, the air rushes in to fill. These lamps will not only burn in air, but will actually burn in water. Here I have a lamp which on placing in a bowl of water continues alight in the water just as well as in the air. You can imagine what an immense boon that is to our divers and others who unfortunately have to work under water for our benefit.

I will not attempt to occupy your time in speaking of the beauties of this wonderful light, how it removes really poison from our air, how it is very good for sore eyes, because it burns with such steadiness that those who work under it really never find, in any shape or form, any inconvenience or discomfort to the eyes. It is extremely cleanly; it does not fill the air we breathe with noxious fumes. People are little aware of it, but it is a very simple calculation to show that thirty gas-burners produce a gallon of water in an hour, so that if you have thirty burners in a shop, for instance, alight for six hours, six gallons of water are produced, and the water can very often be seen running down the cold windows of shops. That water absorbs sulphur and sulphuric acid, and when deposited on books and decorations destroys them. If we could only get the electric light cheap, delivered at our doors, then everybody who has an idea of luxury and comfort would at once take it.

I want now to show you some of the dodges of the electric light. First I will show you that by the action of a cut-out an excess of current is prevented from injuring the lamps. A cut-out is inserted so as to protect a group of lamps here, and on a large current being sent you hear a crack, and the lamps have gone out; the safety fuse has perished in performing its duty. To prove this we will renew the cut-out, and on the proper current being turned on you see the lamps are sound. Here is an electric cigar lighter. I raise this up and the wire in front of it comes to a state of incandescence, and I have there, as you see, sufficient heat to light my cigarette. Some years ago I had my daughter's doll's house, which was furnished by heaself, fitted up with the electric light, and I thought that some of my younger hearers to-night, who were still in the doll age, would appreciate the way in which a doll's house can be lighted up by electricity. You now see the doll's house illuminated; it has a hall-door lamp, which lights up on the opening of the door; the house has rooms furnished, occupied with handsome dolls, and fitted with every kind of contrivance; the doll who occupies the drawing room has the convenience of a portable lamp which she can move about wherever she likes, and each room and the kitchen has a particular form of lamp.

I have also here a model of that famous ship the "Captain," which was wrecked off Cape Finisterre. The model has been fitted with electric light, and you now see the mast-head light, the red light for the port side, and the green light for the starboard side. There are high jinks going on in the saloon by the aid of the electric light; and there is also a search light which can be used for looking for the advance of the enemy. A beautiful phosphorescent effect is produced upon the water, which is covered with blue cotton wool in which a lamp is placed causing really a very pretty illustration of what the phosphorescence of the sea is like.

Here I have an apparatus for heating curling tongs by electricity; here is a flat iron treated in the same way, and here is a kettle in which the current is carried to boil water. I travel a good deal, and I always carry in my travelling bag a battery like this, which is one of Pitkin's secondary batteries. It is light and extremely convenient; I can strap it on my shoulder like an opera glass. To this is attached a reading lamp which I fix in my waistcoat, and to the astonishment of my fellow travellers, when the shades of evening are beginning to set, I I take out the lamp and put it in operation so. My reading lamp is thus provided. and it is fixed in the most convenient position, for the light falls just where it is wanted, it does not offend the eye, and enables me to read the smallest print. I have always got with me my own light, perhaps much to the annoyance of my fellow passengers, and with the electric light machinery at my own house I have little or no trouble in re-charging the battery, or keeping it in order. The Pitkin battery is also applied to a miner's lamp. The effects of this wonderful power of electricity that we possess can be shown in many ways, and there are many other applications to lighting which I should have liked to mention, but I have much exceeded my allotted time, and must leave the rest of my subject until next Wednesday, when I will show you electricity in another form.

(To be continued.)

EDISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

THURSDAY, APRIL 26TH—*continued.*

Cross-examination of Mr. R. P. SELLON resumed: You began by describing that in your filament you used cellulose?—Yes.

Do you know what the chemical constituents of cellulose are?—I am not a chemist; but it is a woody fibre, oxygen and hydrogen being the main constituents. The wood fibre is the carbon. I think the chemical formula is $CbH^{10}O^{5}$.

In the lamps submitted as the result of the manufacture of your corporation there is a carbon filament within a receiver made entirely of glass, through which the leading wires pass, and through which the air is exhausted?—That depends on your definition of a filament. In the sense that filament is now a common term, applicable to the burners of any incandescent lamps, what you say is true.

With your filament prepared in the way you have described, are the defects remedied by the flashing remedy—the defects in the deposit of carbon?

Mr. JUSTICE KAY: He said so.

Mr. ASTON: Now, you have said that the production of the slender carbon material requisite for the Edison lamp according to his process was unknown at the date of Edison's specification?—The carbonising of such filaments.

The persons who would be employed in the manufacture of electric lamps would be persons accustomed to electricity in the first instance?—Not necessarily. I do not see that there need be any necessary association between a knowledge of electricity and a knowledge of incandescent lamp manufacture.

Suppose a person who read Edison's specification tried to make an electric lamp, would not an electrician, in your own opinion, be a person likely to be consulted, and likely to give directions as to the putting of the parts together?—He certainly would, I imagine.

It is a fact, is it not, that in works where electric lamps are now made it is by no means unusual to have gentlemen like yourself capable of understanding the application of electricity?—At the present day no doubt it is.

On the Court resuming after luncheon,

Mr. ASTON continued his cross-examination of the witness as follows:—

I understand you are the manager actually operating at the defendants' works?—No; I am not the manager, I am the chief electrician.

And your duties would be directed, I suppose, to giving directions as to the proper way in which lamps should be manufactured and tested?—Yes, amongst other duties.

Am I right in saying that in reading Mr. Edison's specification you did not overlook the fact that he directed attention to a prior specification, regarding which he says that in a prior specification, dated June

17th, 1879, 2,402, he has set forth the evidence of resistance by long lengths of platinum wires?—I did not overlook that.

Is it not a fact that in that specification Mr. Edison refers to the operation of what we call "flashing," electrical heating, or exhausting for the purpose of expelling the gas?—He does refer to the driving out of the cruder gases, no doubt.

That was by passing the electric current through the material operated upon, and so enabling the gas to be expelled?—Yes.

And he says carbon can be treated in that way?—Yes.

Taking into consideration what you find in Cheesborough, do you not think an electrician like yourself in 1879 would know you might very advantageously improve by treating in this way and by driving out the cruder gas?—I think it is extremely probable.

I presume also an electrician acquainted with Cheesborough would in all probability use this process too for the purpose of improving his burners?—My recollection is that Cheesborough does instruct you to drive out the cruder gases—those are his words.

Therefore, an electrician in November, 1879, acquainted with those two processes would know he could improve the burner considerably by finishing off the carbonising in this way?—No answer.

Mr. JUSTICE KAY: Is not this all argument?

Mr. ASTON: I admit that it is so.

Resuming the cross-examination, the learned counsel asked: Do you think in any of these cases in which you got a very friable light in your burner you might have obtained a less friable or fragile result if you had more temperature?—I think the result of the carbon would have been less at a lower temperature; but, on the other hand, the quality of the carbon would be much more of a loose form, like charcoal carbon.

Suppose you had a loose form of carbon, and wanted to make it better suited for your purposes of burning, you could have known you might have subjected that to Cheesborough's process?—As a matter of fact I did not know. I cannot say.

Suppose you had known at that time Cheesborough's process, what would have been the result?—A manufacturer of lamps who is aware of Cheesborough's process, or the process of electrical heating, would probably have followed it.

And would not that have improved the specimens?—It might.

Might you not, by your knowledge now of Cheesborough's process, improve every one of those specimens?—No doubt it would have rendered them less fragile.

But what you have done has been to follow strictly your own reading of Edison's specification, and you have given the result?—That is what I have endeavoured to do—to follow Edison's specification.

Is it true that Edison indicates in his specification that it is advisable not to have a filament that is liable to crack and break, but a filament that is homogeneous and made of carbon?—I understand the expression is as homogeneous as possible; but he has previously told us that you can increase your resistance by mixing up with your putty carbon volatile and non-conducting matters, such as oxide of zinc, and he then goes on to say he prefers to put in as little of that non-conducting matter as possible, and so obtain his filament—in fact, his filament is to be as homogeneous as possible.

Do you not think the three specimens which you give me here, if carefully manipulated and put into the lamps, might produce good results?—Those specimens might with difficulty be mounted, but the further difficulty that would meet you would be that you would not be able to obtain your vacuum owing to the fact that the platinum had undergone a process of carbonisation, and is thereby rendered porous.

Is it not a fact that you always have, in the delicate processes you have to superintend and direct, to make allowances and correct inconveniences by your experience?—Oh, yes, obviously.

You heard the evidence given by Mr. Edward Gimingham?—I heard a portion of it. From what I heard of his evidence, and what I have read in the shorthand notes, according to my understanding of Mr. Edison's specification, he did not follow out Mr. Edison's instructions, and therefore I think the lamps produced were not Mr. Edison's lamps within the meaning of this specification.

He supplemented Mr. Edison, you think, by information outside of his specification?—I think he did that. To mention one respect in which he did not follow the specification, the platinum wires were not subjected to a process of carbonisation under the conditions prescribed, as I undersand, by Mr. Edison.

In the specimens produced by you, R P S 11 and 12, have you not a comparatively rigid stick of carbon?—It is rigid, no doubt.

Have you caused that lamp to be lit?—I have seen this lamp burning for several hours.

Do you not know that Mr. Swan spoke of his experiment as an experiment which would require to be perfected in order to be successful in operation?—He may have done so.

Mr. ASTON having quoted from the books on the subject, the witness said: I have read that before.

At that time, February 4th, 1879, was there any indication that he had solved the problem?—He does not appear to have thought so.

Mr. ASTON was about to quote from a letter at page 79 of the third book—a letter from Mr. Swan.

Mr. FINLAY said if his learned friend intended to put these things into the process he would not object; he assumed the learned gentleman was going to call Mr. Swan.

Mr. JUSTICE KAY: What kind of evidence can this be? Mr. Swan does not appear to have thought the experiments successful. If you oblige me to take such things down I shall be obliged to remark upon them.

Mr. ASTON: When did your company first make electric lamps?—At the end of 1879 or the commencement of 1880. They acquired the patent rights of Mr. Lane-Fox, who had for some time previously been engaged on that work.

I want to know when the company as a company first made or sold lamps in this country which were invoiced by the company?—I believe in 1880, certainly in 1881; but I cannot speak to the definite date.

When did you begin to make lamps after the process you describe?—About the year 1884.

Mr. WILLIAM CROOKES, examined by Mr. GRAHAM, deposed: I am a Fellow of the Royal Society, President of the Chemical Society, and Vice-President of the Society of Telegraph-Engineers. I have devoted great attention to electricity during the last thirty years. In 1864 Mr. Sprengel first published his book, which was described in the *Transactions* of the Chemical Society shortly afterwards. Between that year and 1872 I used Sprengel's pump in a very large number of investigations, and it has been in constant use to my knowledge.

I believe you performed those experiments which Sir Frederick Bramwell described as wonderful?—Yes.

And those experiments required vacuum matter of extreme perfection?—Extremely high.

You have been familiar with the working of close sealing for a great many years?—I have.

When did you first give your attention to the manufacture of incandescent lamps?—About the year 1880.

And since then you have seen every form of incandescent lamp that has been introduced to the market?—Yes.

Witness was then examined as to certain experiments which he had made, and his evidence had not concluded when the Court rose at four o'clock.

The further hearing of the case was adjourned till Monday.

MONDAY, APRIL 30.

Mr. WILLIAM CROOKES was further examined by Mr. Graham as follows:—

On Thursday I omitted to ask you whether you did not light your own house in the year 1881 with incandescent light?—I lighted my own house in Park gardens with electricity in 1881, and I have continued to do so ever since.

What sort of lamps did you use in 1881?—I used every kind of lamp. I commenced with lamps of my own manufacture, and then used Edison's lamps and the Maxim lamp. Afterwards I used Swan and Lane-Fox's lamps.

In the process of carbonising, Sir Frederick Bramwell stated that in his opinion sand would do?—From my chemical knowledge I feel convinced that sand would not do for such a delicate filament. Although I knew what the result would be I put over 100 filaments in dry sand, and packed the crucible tightly with the sand, gluted the cover with fire clay in the way adopted by metallurgists when they wish to keep air out of the crucible, then raised the temperature gradually to a full yellow heat. I exhibit specimens of paper, cotton, linen, card, cellulose and wood, before carbonisation, and I also exhibit the remains which were got from the sand after carbonisation. Everything is burned except the card, which contained so much inorganic impurity that it has left a coherent ash, which is not carbon; the whole of the carbon is burned out.

The witness then entered into a minute description of the experiments which he had made in attempting to carry out the directions in Edison's specification, the result being that no successful lamp was produced in any case, although by introducing certain modifications in the process it was found possible to make a lamp capable of burning for a brief time; but in no case were the results of a commercial character.

Have you ever seen lamps made according to Edison's directions only on the market?—Certainly not.

In your opinion does Edison's specification contain directions to enable capable workmen in 1879 to make a working lamp?—I do not think the specification contains sufficient directions to enable me with my present skill to make a working lamp.

Mr. JUSTICE KAY: Did you see the lamp you spoke of in Paris lighted?—I saw it lighted for a few minutes.

As to Deprez's process, you have been carefully through it?—I have been.

In your opinion are there any passages which refer to passing the current through?—Many of the passages refer to incandescent experiments in contradistinction to an arc experiment. There are 19 experiments which are incandescent, about three which are arc, and the others doubtful.

Contrast the process with that of Cheesborough?—Contrasting the description given with the description in Cheesborough, I should say the processes are identical and the results are identical.

In your opinion if this paper had been put into the hands of competent workmen at the date of Cheesborough's patent, would they have been enabled to get the same results?—I consider this a very fair description, and a workman could not have failed to get the same results if he had tried it.

Turning to Sidot's paper, what do you say about the material from the description as compared with Cheesborough's material?—It is very similar material, produced in a similar manner.

As a matter of fact, are there any occluded gases in Cheesborough's material?—There would be, certainly; it could not be quite free from them.

Have you made any experiments in heating with hydro-carbon gases?—I have made a great many experiments and have succeeded practically with all of them.

Did you try any hydro-carbons with which you did not succeed?—No; I succeeded with all the hydro-carbons that I tried.

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What do you understand by hydro-carbon?—A compound consisting entirely of hydrogen and carbon with no oxygen present.

Did you try any substances consisting exclusively of hydrogen, carbon and oxygen which failed? I tried formic acid, which failed. Glycerine failed also. I tried mixing alcohol and water together until it got to the point at which it failed; but that is not a chemical compound.

Mr. JUSTICE KAY: Was that because there was too much water or too much alcohol?—It failed when the water got to a certain point.

Witness was next referred to page 15, line 48, of the specification, and asked, speaking as a chemist, Have you formed any idea of what are included under the terms "infusible substances, non-conductors of electricity?"—I should think substantially the list I have handed to you. [This list consisted chiefly of metallic oxides and some sulphates.] To the best of my knowledge, the whole of these bodies are included under the words "infusible non-conductors." There is a difficulty in answering the question, because I do not know the meaning of the word infusible. Of course, everything, I imagine, would be fusible if you heat it high enough.

I believe you carried out certain experiments with reference to Cheesborough?—That is so.

What was your first experiment?—My first experiment had reference to line 5. I took a cylinder of lime, and drilled a hole through it. The cylinder was about ⅜ of an inch diameter and ⅝ inch long. The longitudinal hole was about $\frac{1}{50}$th of an inch in diameter. From the centre I passed a stick of Carré carbon half a millimetre in diameter. I then clamped the two ends of the carbon rod which projected at the ends to conducting wires, placed the whole in an atmosphere of coal gas bubbling through benzol, and passed an electric current through the rod of carbon. The carbon was raised to a good white heat; that heat raised the surrounding silica of lime to a good red heat, and carbon was deposited in the pores of the cylinder. The lime was originally white; the dark colour is produced by the carbon deposited. I then cut the carbonised lime into small rods. [Rods produced.] I mounted one of those in a lamp, and passed the current through it. The lime originally was a non-conductor of electricity, but introducing carbon into its pores made it a conductor. The current was turned on, and it was raised to a red, and then to a full yellow heat. At that temperature the oxygen in the lime united with the carbon, carbonic acid was formed, depressing the mercurial gauge, calcium was volatilised, depositing on the sides of the glass, and the stick broke. The light evolved during this decomposition showed calcium lines on the spectrum. The carbonic acid depressed the gauge, the pump was set to work a little longer, and the gas collected. By chemical tests I showed it was carbonic acid. I have the results here. I repeated that experiment in the presence of the gentlemen I have named, and this is the lamp. [Lamp produced.] I have here an unbroken lamp, produced in the same way, with which the experiments will be repeated when desired. The temperature at which this lamp broke was much below the ordinary temperature of an incandescent lamp. I tried experiments with three things besides lime, selecting therefrom the best, which I have prepared. I used a cylinder of fireclay of similar dimensions to those given to the lime, passed a stick of carbon through, and tried it in the same way. The metals were volatilised, the carbon united with the oxygen, forming carbonic acid, the gauge was depressed, and the gas was tested. The lamp was coated with a black deposit, and the conducting portion broke. I next tried magnesium, and the result was the same. Asbestos, zirconia, alumina, silica, and thoria were also tried, and the result was the same. I am quite certain the effects produced in these cases would have been produced with the other specimens on the list. I did not choose those most likely to fail. I took them for a fair trial.

Cross-examined by the ATTORNEY-GENERAL: Regarding the experiments you put in this morning. When did you conduct that series?—Not many days ago.

A little nearer than that?—I cannot recollect the precise time, but it was since hearing Sir Frederick Bramwell's evidence.

In your examination in chief you told us that you succeeded last Saturday in making a filament. Is it not the fact that a series of experiments were conducted on Friday and Saturday last?—Oh, certainly not.

When were they made?—A few days before the commencement of this trial.

You said, Mr. Crookes, that was done in order to test what Sir Frederick Bramwell said?—Yes.

When did you do that?—If you can tell me the date of Sir Frederick Bramwell's examination I will tell you.

He gave evidence on the 17th April?—Well, it was done the same night.

That would be last Tuesday night week?—Yes.

Was this experiment carried out on the night of the 17th?—It was.

Have you communicated the result to your solicitors?—I communicated with them afterwards.

The next day?—I think I wrote a letter to Mr. Sellon, the principal witness for the defendants.

Were you present when Mr. Gimingham and Dr. Fleming were examined?—I was.

Speaking of Edison's patent broadly, you say there are not sufficient instructions to enable workmen to carbonise a filament?—I say so.

And, secondly, carbonising a filament of platinum wire produces porosity?—Yes.

Am I right in saying that these are your two main attacks on the Edison patent?—I think one most important of all is the impossibility of making a putty tar filament.

These are the three main attacks?—Yes, I think they are.

Did you try to make a lampblack tar filament before the 17th of April?—Yes.

When did you first try?—It is impossible to give the exact date—some weeks ago.

Did you keep a record of those early experiments?—I did.

Did anybody assist you in your experiments?—My assistant helped me.

Anybody else; taking the 17th April down to those completed last Saturday, had you anybody assisting you?—If you do not refer to the instances in which I repeated experiments in presence of the gentlemen named, I had not anybody assisting me.

Are you acquainted, or are you not, with the carbonising process?—I am acquainted with it.

Were you in 1879 acquainted with carbonising processes?—I was acquainted with the process of making charcoal for gunpowder, but I was not practically acquainted with more delicate processes.

Were you, or were you not, as a chemist, acquainted with what was called the process of carbonisation?—I was.

I understand you to represent that the idea of carbonising these filaments in sand is an absurdity?—It is an absurdity.

You do not suggest that either sand or charcoal are mentioned in the specification—simply carbonisation?—Simply carbonisation.

What is the reason why, as compared with charcoal packing, sand is an absurdity for packing those filaments?—Because there would be so much air in the interstices of the sand that the delicate filament would be burned up.

So much air in the interstices of sand as compared with the interstices of carbon, I presume you mean?—No.

As compared with what?—There would be practically the same amount of air in the interstices of the sand as in the interstices of the carbon, and there might, perhaps, be more in the interstices of the charcoal than the sand.

You stated just now that packing with sand was an absurdity as compared with packing with charcoal for carbonising a filament. Tell me what it is in sand, as compared with charcoal, that makes it an absurdity, or an impossibility to carbonise filaments in sand?—When the temperature rises to the carbonising point and the oxygen in the interstices of the charcoal is used up by the charcoal itself, its action on the filament is prevented. But, when the sand is heated up to the same temperature the oxygen in the pores of the sand has no carbon to attack, except a small quantity in the filament.

Then that, for very broad purposes, is a sufficient answer to the question of what I call an absurdity, and what you call an impossibility?—I think so.

Shown box and asked—Will you swear that these filaments have not been carbonised in sand?—Certainly not. I am not going to swear anything about them.

A few minutes ago you told me that to carbonise a filament on sand was an impossibility. If so, will you tell me why you will not say these have not been carbonised in sand?—Impossibility is rather a stray word. I did filaments like that myself in sand, and I might do an enormous number of such. I should trust, however, to the outside filaments being burned up, and taking all the oxygen and a few filaments in the inside might be left. I was not by any means playing tricks.

We will see about playing tricks before this case is over. Did you mean just now to tell me it was absurd or impossible, and could be done or could not be done?—You put the words into my mouth. I used them in reference to the process in this patent.

I wish to have an answer to the question. When you answered the question I put to you a few minutes ago, did you mean that it could be done or not done?—I am speaking in reference to the patent, and I understood your question had reference to it. I mean that the process could not be carried out practically.

The Court then rose for luncheon, and, on reassembling,

The ATTORNEY-GENERAL continued his cross-examination of Mr. Crookes as follows: Before I pass from carbonisation of sand, would you kindly look at those lamps [Shown lamps.] Will you undertake to say that the carbon filaments in those lamps have not been carbonised in sand?—It is impossible to say by looking at them how they have been carbonised.

Do you represent that for the purposes of carbonising filaments any packing at all is necessary?—No.

Was it not in 1879 well-known that you could carbonise filaments of carbon, or any other kind of carbon, according to the cubic contents of the vessel in which they are carbonised?—It is self evident to a chemist that if the amount of the oxygen in the vessel is very small and the amount of carbon in the filaments it contains very large, and no further oxygen comes in by the time the whole of the contained oxygen was used up in burning some of the filaments, there would be a few filaments left untouched.

I do not think you are doing yourself justice, Mr. Crookes. Was it not well known that it was simply a question of the relative bulk of the carbonising vessel and the bulk of the wood or other material put into it?—Yes; that would be well known to a chemist, but not to workmen.

Was it not well known to those accustomed to carbonise?—I suppose it was. I cannot answer for myself definitely, but I suppose it would be.

What was the size of the vessel in which you attempted to carbonise, Mr. Crookes?—It was a small-sized clay crucible, the smallest crucible which would take these filaments in.

How many filaments did you put in?—Over one hundred.

Will you please tell me as accurately as you can the relative volume of material you put into the cubic contents of the vessel?—It is impossible to say.

What was the specific gravity of the wood or material you used?—I did not take the specific gravity of it or any part of it.

You are sure you put 100 filaments in?—More than 100.

Cannot you, as a skilled chemist, give me an idea of the specific gravity?—I really cannot; I should have to refer to my books on the subject.

Was it not perfectly well known by people accustomed to carbonise that

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twelve drams of carbon required 112,000 centimetres of air for their complete combustion?—I will take that from you as a scientific fact.

Was it not perfectly well known to people who carbonised?—I cannot say.

Was it not elementary chemical knowledge that these were the proportions required for combustion?—It might be calculated by scientific men, but I do not know, it is impossible to tell you.

Did you know, or did you not know in 1879, that a very large multiple of the number of times of filaments of carbon were required to complete burning?—I did.

The exact quantity you do not know?—I know it is against many chemical facts; I have not every figure in my brain, but a few minutes' calculation would give the result.

I am not asking about carrying in your head a few minutes' calculations. Was not the calculation a matter of elementary chemistry?—Of course it can be calculated out by any chemist, but I do not know many people who would carry the calculation in their heads.

Whether it was elementary chemical knowledge or not, it could be ascertained by reference to text books?—It might.

Did you ever happen to measure or weigh an ordinary filament such as that described in the books?—No, I do not think I ever have. It would be a very small fraction of a grain.

Assuming it is an eighth of a grain, is it not a fact that, roughly speaking, three cubic inches of air would be required to complete combustion?—I suppose you are correctly informed. I will take it if Prof. Dewar says it is so.

Until these experiments, had you, for yourself, made filaments or any small things?—I have.

Successfully?—Yes.

Packing charcoal is what you yourself use?—Yes.

Where did you get your information from?—With my chemical knowledge it was obvious to me.

Was it not perfectly well known in 1879 that for the process of carbonisation it was a common experiment in process to pack things to be carbonised with charcoal?—It was not in the manufacture of carbon for gunpowder. I am not aware that carbonisation was carried on except for gunpowder.

Do you mean to say that carbon-electros were not commonly made, and commercially made?—Yes, of course; I forgot.

Was it not a perfectly well-known and common process for carbonising wood, or any material going to be made into a lamp, to pack it with powdered charcoal?—I do not know that it was common knowledge. I believe in some of those cases they packed it with sand.

I call your attention to the statement in "Watt's Dictionary of Chemistry," published in 1875, page 255?—The dictionary is a standard book, and perfectly correct in the statement to which you allude, which every chemist would know.

You are aware of those patents for carbonising various conductors, from 1845 downwards. Can you tell me one in which what I may call the process of carbonisation is described beyond the statement that it is carbonisation?—I cannot remember one, but I do not say there are none.

Was it not perfectly well known that the time carbonisation took depended on the character of the vegetable matter?—I do not think there was much difference. There might perhaps be in extreme cases a difference, but I do not think much.

Was it well known it should be slowly tried and slowly heated?—I do not think it was.

Having regard to the tar lampblack, would any chemist think of moistening such a substance as that with water?—Certainly not.

Tar and water will not combine, will they?—No.

Carbon and water will not combine?—No.

Look at this box. [Shown box]. You could not say these are not tar and lampblack filaments?—I cannot say.

Tell me with reference to any one of these exhibits 7, 8, 9, and 10, what was the resistance you ascertained before the lamp broke down? [Shown lamps.]—I took no resistance on those lamps.

You did not take the resistance cold in any case?—Not quite cold.

What current did those lamps break down respectively at?—I cannot say; they were only about white heat.

Do you know what the pressure was before the lamp broke down?—No; they broke down before I commenced to measure.

Witness was further examined by the ATTORNEY-GENERAL in regard to the porosity of platinum, and, in reply, said: I should like to explain that porosity is not produced by the action of the silicon or carbide on the platinum so much as by the action of the air on these compounds. If silicide of platinum is heated to the burning point of platinum the silicon burns into silica, which fuses and forms a sort of glaze on the surface of the platinum; but if the carbide of platinum is heated to a high temperature, the carbon melts, forming a gas, leaving the platinum porous. For that reason I should think the action of carbon would leave a much more porous platinum than the action of silicon.

The Court then adjourned till Tuesday.

TUESDAY, MAY 1ST.

Mr. CROOKES was futher cross-examined by the ATTORNEY-GENERAL. He stated—I am myself a patentee of electric incandescent lamps, and have a patent dated March, 1881, for an incandescent lamp containing a carbon filament. I proposed to purify the carbon by hydrochloric acid. I did not think it necessary at that period to give any directions as to how the filament was to be carbonised.

Do you represent that there has been any publication between April, 1880 and September, 1881, when your complete specification was filed, of any directions respecting the mode of carbonisation?—At the date of the patent incandescent lamp factories were in full operation, and it was well known how to carbonise. That patent was addressed to the people of these factories and not to the public. Edison published full particulars in the patent subsequent to the one sued upon, and that I fancy was between the two dates you named. His patent of 1879, No. 5,127, contains directions for carbonising. So also does his patent of 1880 for a bamboo filament.

Do you suggest that there is anything in either of the passages you have read as to the process of carbonising that was not perfectly well known to the people who carbonised in the year 1879?—I cannot answer. Edison knew all about it.

Have you practically carbonised electric arc carbons prior to 1879?—No, I never made any.

Had you used any Lane-Fox lamps?—Not in 1881. I have only used them recently.

You say you had used it as early as 1881?—It was a mistake if I did, but I do not think I did.

When did you use Lane-Fox first?—In the Paris Exhibition I was one of the jurors, and I was on a sub-committee to examine all the incandescent lamps, and on that sub-committee I examined and reported on the Edison lamp, the Swan lamp, the Lane-Fox lamp, and the Maxim lamp.

Did you know that the filament and broom used by Lane-Fox was treated by the Cheesborough process?—No.

When you tried those experiments which you described yesterday you put a substance upon the tar and lampblack filament?—That was one experiment. I made a great many experiments.

I am referring to that in which you used a filament of tar and lampblack?—It was a tar and putty filament.

You told us that the best filaments you could make were made on the palm of your hand?—Excuse me, I said that I had a large percentage of carbons where the substance was so fragile that I could not succeed to roll it out in any other way.

[Shown lamp]. Is not that a filament which you made by rubbing it in the palm of your hand?—No.

How did you make it?—I rolled it between two bits of glass.

[Shown three lamps.] Do you suggest that these filaments are uniform filaments?—No.

None of them are uniform?—No; they are full of cracks.

I am not speaking of cracks. Are they uniform in the sense of being of uniform diameter?—No.

Are you aware that Edison points out that it is important that the wires or filaments should be uniform in size throughout?—Yes. I did my best to get that.

If not uniform in size, you would have much greater heat at the narrowest cross-section?—Yes.

You would have the points of light unequal, which would be corrected or improved by the Cheesborough process?—Yes.

And the more "un-uniform" the more liable to break down?—Yes.

Did you try fireclay with a uniform filament?—I tried with the most uniform filament I could get.

You have just told us that these filaments were not uniform. Have you tried it with a uniform filament?—I have tried it with a filament which was rolled out uniform, but in curling it to make a horseshoe, it has cracked in many places and therefore became "un-uniform."

I wish an answer to my question. Have you tried with a uniform filament?—It is impossible to answer yes or no without giving an explanation; it would cause an erroneous impression.

You have given an answer that the filaments you took were as uniform as possible. Have you tried what Edison described as a uniform filament?—I have not.

[Shown lamp now put in.] I suggest to you that that is an ordinary carbonised parchmentised thread lamp, coated with silicate of alumina. Do you suggest when such a lamp was running that the presence of silicate of alumina or silicate of magnesium would break down the filament?—This lamp is useless.

I am aware of that; it is open, I mean a perfect lamp of that kind?—It is coated with fusible silicate of alumina. If you ran it very high reduction would take place.

Do you give the same answer as to another lamp now shown you, coated with silicate of magnesium?—Yes.

That would be useless?—As a practical lamp, yes.

If it was heated to anything like what I should call ordinary incandescence the result would be that there would be destruction of the carbon?—Yes.

[Shown two lamps with globules of silicate in them.] Would you undertake to say that these are not coated in exactly the same way, one with silicate of magnesium and the other with silicate of alumina, running with the electric current so high that the silicate of alumina was fused and came off in globules with the filament perfectly uninjured?—No; it is not parallel to the Edison case.

I am not asking about Edison. You said a moment ago that both the lamps now worked, Nos. 27 and 28, so coated, would be useless on the ground that when heat was applied to raise them to incandescence, the silicate would attack the carbon and destroy the filament?—That is my experience.

Then will you undertake to say that the other two lamps now marked 29 and 30 are not two lamps which have been coated, like 27 and 28, with silicate of alumina and silicate of magnesium, and raised by the electric current to such a heat as actually to fuse the silicate, and yet to leave the filament absolutely uninjured?—It does not need much heat to fuse silicate of soda. This lamp is marked "of soda."

Would you answer my question?—I say under these circumstances it would not be possible to do it.

Will you undertake to say that that is not so?—I cannot undertake to say that.

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A moment ago you said, in regard to 27 and 28, which are identically the same lamps, that it was impossible they could run. How do you reconcile that with your present statement?—I had the Edison design in my mind, and you say I am not to refer to the Edison patent.

I cautioned you twice about their not being the Edison patent. I put to you these actual lamps, and told you it was a parchmentised thread, and asked you whether these two lamps could be burned as lamps, and you said no. Will you tell me what are the circumstances to which you now refer?—The circumstances are these; in the Edison filament it is an extremely porous filament, which will suck up the fused silicate like a sponge, and allow the chemical action between the silicate and the carbon to take place. These filaments are very fine horny non-porous filaments, which will allow the fused silicate to rub off easily. Moreover, there are very many silicates of these different substances varying in fusibility, and I suggest, although I cannot say that it is so, that they may have chosen very fusible silicates for these experiments.

You gave evidence as to rolling the filament out on a glass plate after sifting finely powdered fire clay over it. In other words you got more or less of this silicate of alumina incorporated in the surface of the filament?—Yes.

Did you try any filament coated with the actual substances mentioned by Edison?—These are cerium, lime, and magnesium.

Will you produce any lamps in which you used cerium, lime or magnesium before carbonising?—No.

Did you coat any filament with cerium, lime or magnesium before carbonising?—No; I did not.

Why did you not try one of the things Edison has mentioned?—I knew perfectly well that the result in this case would to my mind prove exactly the same thing as in the other case, and this was so much easier.

Why did you not put cerium in your test?—It is such an out-of-the-way thing; probably I forgot it at the time.

You said yesterday that there was no difference, assuming sufficient heat to be used, between Sidot's and Cheesborough's processes. You said, "So long as the heat is sufficient it does not matter how the heat is produced?"—Yes.

Would external heating correct the irregularities in the slightest?—Certainly not.

For incandescent electric light do you suggest that anybody before Cheesborough had pointed out the advantages gained by internal heating in hydro-carbon gas?—I do not think it had been pointed out except in the paper which has been put in.

Pardon me for asking you to answer my question one way or another, and I will give you an opportunity of dealing with the exception. Do you suggest that anybody had pointed out the advantage for incandescent lighting of internal heating in a hydro-carbon atmosphere?—No, I do not. I think I first consulted Desprez in 1849, a year or two after the publication of his statement in the *Comptes Rendus*. I began the experiments which led to my patent of 1881 some time in 1880. When I began to make incandescent lamps I did not specially consult Desprez; I knew it very well. I have made Desprez carbons.

Witness was then cross-examined in detail as to the Deprez filaments, and the time he kept them in the hydro-carbon bath.

Re-examined by Sir HORACE DAVEY: I remember the lamp which was put into my hand yesterday, and said to have been made by the Edison Company, with a bamboo filament. Assuming that was so, I said it was within the description contained in the second claim of Edison's patent. Assuming that the bamboo lamp has been made since the date of the patent, and in accordance with the second patent of 1880, that would not be a lamp which in my judgment was made in accordance with the terms of Edison's specification. As to my experiments in carbonising, I put a hundred or more filaments into the crucible, and I filled it up with sand.

Was that a fair experiment for the purpose of testing whether sand would answer the purpose?—I tried to do it as fairly as possible. The heat to which it was subjected in that experiment was the ordinary heat which would be used for carbonising and obtaining a successful result.

You were referred to the expression used by Edison—a closed chamber. Was any patent known to you or is known now for closing a chamber for the purpose of carbonising except that adopted by you of gluting with Stourbridge clay?—There is no better method. There was nothing in the directions contained in Edison's specification which would lead a workman to know he was to fill the crucible entirely with the materials to be carbonised. I should not think it would be in accordance with the ordinary mode of carbonising.

Have you any doubt after the cross-examination you have been subjected to on the subject that, as a practical means of producing filaments, carbonising in a crucible padded with sand would not be a practical mode, although you might now and again get a filament?—It might be possible to get a few out of a hundred carbonised in sand.

You told us as to rolling out the putty thread. Did you try several experiments as to the best mode of rolling out the putty thread?—I remember an enormous number of experiments. I rolled the thread on a plate of polished glass with a spatula. Then I tried a plate of fine ground glass with a spatula; then I tried both polished and ground glass as a basis; then a piece of plate glass polished and ground, and rolled the thread on that. I rung the changes on all these. Edison does not give any instructions how the filament is to be rolled. I tried such methods of rolling out as are known even at the present day. The putty thread would not bend without cracking. I consider that that cracking would be fatal to the use of putty thread in a lamp. It is possible to bend it without cracking by keeping the mixture in a plastic state by constant vibration. Then you can coax it round, but that is a very difficult and a very tedious process, and quite impracticable as a manufacturing operation. I was at work for several days before I struck on that plan. Ultimately I tried rolling in the palm of my hand. That was in one case only. Everything else failed. The filament was so frail. That was in the case of camphor.

The Court then adjourned.

WEDNESDAY, MAY 2.

The re-examination of Mr. Crookes was continued by Sir HORACE DAVEY, as follows:—

Referring to your patent of 1881, No. 1,422, was the object of that patent to get rid of impurities in the manufacture of carbons, and not any method of carbonisation?—Yes.

At the date when you took out your patent can you say whether there had been any advance in the knowledge of carbonising those filaments?—There had been a very great advance in the knowledge of the people to whom the patent was addressed; I will not say the general public or ordinary general manufacturers of electrical apparatus—they would not be interested in getting rid of the impurities from carbon—but the patent was addressed to people engaged in making lamps.

Witness further said: With regard to the lamps containing parchmentised threads coated with silicates of alumina and magnesium, silicate of alumina is the name given to a large class of bodies containing silica acting as the acid, and alumina acting as the base, in various proportions. These silicates differ considerably in fusibility. *Mutatis mutandis* the same explanation applies to silicate of magnesium. Silicate of soda is a combination of silica and soda; soluble glass, I think, it is called. It is much more fusible than ordinary glass. Soda is the oxide of sodium; silica of soda is very fusible for a silicate. Much depends upon the proportions between the silica and the soda; the more soda present the more fusible will it be.

Sir HORACE DAVEY: It was suggested that in the lamps shown the silicates had fused and run off, instead of attacking the carbon?—Yes.

Would it make any difference in the silicate, when exposed to high temperature attacking the carbon, that the thread had been parchmentised, and was of a dense homogeneous character?—It would make a very considerable difference.

Would the experiment shown in these lamps be a fair test of what would happen in a coated filament prepared in accordance with Edison's specification?—I do not think it could be called a fair test.

There is no direction in Edison's specification, for example, with regard to parchmentising?—None at all.

And would parchmentising make a material difference in the character of the carbon?—It would make an enormous difference.

If the carbon were of a coarse-grained character would it be attacked by the silicate sooner or later?—Very much sooner.

And if it were dense it would take a longer period?—Very much longer.

Would there be any practical advantage in making a practical lamp in putting on silicate of aluminium and melting it off?—I have experimented very largely in making these filaments, and I have found, without exception, that anything put on the carbon diminishes its power of lighting.

What is the advantage of putting anything on it at all?—I do not see any advantage.

Having regard to the description by Deprez of the material which was in use in preparation, was the material which you exhibited as produced by you following, according to your understanding of it, Deprez's experiment, the same material or not?—It was exactly the same material.

Take Cheesborough's description of the material. Is the material you exhibit, in your judgment, the same as that of Cheesborough?—The experiments of Deprez are the same as these, the same words apply, the material is the same in its physical qualities and properties.

And the process is the same?—Yes, the process is the same.

Prof. EDWARD FRANKLAND, examined by Mr. GRAHAM, said: For five or six years past I have lighted my house at Reigate with incandescent lamps supplied to me by the Swan Company, at Newcastle. I have also used lamps made by other makers, but for several years I used only the Swan lamps. I was much interested in the electric light, and made a point of seeing all the installations I heard of. In December, 1880, I saw an installation of incandescent lamps at Mr. Spottiswoode's house. They were Mr. Swan's lamps, and Mr. Swan was present and explained the process to the company. The lamps were burning the whole day. They were practical lamps. Soon after, I saw an installation of Lane-Fox's lamps at Bridge-street, Westminster. That was early in 1881. The first Edison lamp I ever saw was in the Paris Exhibition of 1881. In this country I first saw an Edison lamp at the Crystal Palace in 1882. I obtained a specimen of the lamps used from Mr. Sprague. I examined the lamps carefully, as I was chairman of the jurors. I produce the lamps given me on that occasion as a specimen of the Edison lamp then exhibited.

Mr. JUSTICE KAY: I presume the platinum wires here have not been upon it when it was carbonised?—I should think not.

Examination continued by Mr. GRAHAM: In my opinion that lamp was not made according to Edison's specification.

The ATTORNEY-GENERAL objected to a general question of that kind.

Mr. GRAHAM: Will you point out in what respects it is different?—In the first place it is made from a bamboo fibre, which is not mentioned in the specification 4,576. Secondly, the filament must have been carbonised by some process by which great precaution was taken to prevent its oxidation. It is an exceedingly fine filament, which would have burned up if it were not very carefully protected from oxidation during the carbonising process. And I find no directions for so protecting such a filament in Edison's specification 4,576. Next the filament is not

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fastened to the platinum wires—if, indeed, it is fastened to them at all—by the method described in the specification. And lastly, the filament is not coiled and has no resemblance to the drawings. I have never seen anything nearer to Edison's specification than that lamp upon the market. I was in court when Mr. Crookes was examined, and read his evidence in the notes. I agree with him substantially. I saw the results of the experiments of Mr. Crookes with a cotton thread properly carbonised. I saw the thread after it had been carbonised, and I think I saw it actually put into the lamp and exhausted. I did not see it actually made into a spiral; it was made into a horseshoe. The horseshoe was very fragile. I have myself made experiments. I tried to roll out a thread or filament from a mixture of tar and lampblack with a steel spatula upon a glass plate, but could not succeed in reducing the diameter below a millimetre or about $\frac{1}{25}$th of an inch. I subjected splints of boxwood, deal, ash and cork, also threads of silk, cotton, and flax, and thin strips of paper to Sidot's process for one hour. I have made carbon filaments by forcing a mixture of lampblack, pitch, and tar through a fine hole in a drawplate. I have repeated Deprez's process with pencils of boxwood charcoal. I have also submitted a carbon filament prepared on Sidot's process and mounted in a lamp to Deprez's process. I have also made numerous trials of flashing in hydrocarbon gases and liquids, following Cheesborough's directions, but every attempt to reach a temperature of anything like 7,000° F. resulted in the destruction of the filament. The melted pitch destroyed the filament at all temperatures. With respect to the filaments I made, I did not carbonise any of them, but saw them after carbonisation. I did not see the filaments put into the crucible, but when it was opened it contained a quantity of ash, some powder, and part still in the form of filament. There was no packing in that experiment. I have not carried out any experiments on Edison other than those mentioned. I was present in Mr. Crookes' laboratory when the experiments with non-carbonising non-conducting substances were carried out. I think they were made on Monday, the 16th of April, this year. I saw the carbon filament which had been coated with fire-clay, and carbonised either before or after coating, put into a lamp, and the lamp ignited by a current. I viewed that filament through a spectroscope, and at a certain point of the emission I saw a bright spark, indicating the volatilisation of silica and aluminium. I also noticed that the gauge of the Sprengel pump fell at the same time two or three inches, showing that some gas had been evolved. I did not examine the gas, but in a previous similar experiment Mr. Crookes informed me that he had done so. The vacuum was as nearly perfect as a Sprengel pump can give us. When the spectral lines appeared the filament broke and the interior surface of the lamp became dim with a deposit. The phenomena I saw were caused by the reduction of the alumina to aluminium and the reduction of silica to silicon, with the simultaneous production of carbonic acid or carbonic oxide gas, or both, which caused the depression of the mercury in the Sprengel pump. This took place, because at that temperature there is a stronger affinity for oxygen than either alumina or silica. The breaking of the filament was caused by the oxidation of its carbon and the consequent conversion of a portion of it into gas. I have seen the operation of mounting repeatedly. I have seen the platinum wire come out of the carbonising vessel after the process was completed. That was at Mr. Crookes's within the last few weeks. The platinum wires were rough, and I should think, from their appearance, porous and very brittle, so that in mending one of them it broke off. I should say they had been carbonised with packing of charcoal and lampblack. I did not make any chemical analysis of the platinum.

Have you anything to say as to the use of platinum wires which have been carbonised in electric lamps?—They will be quite inapplicable for incandescent lamps on account of their porosity and brittleness—*i.e.*, if any portion of such were projected outside the lamp. A carbon filament within a receiver made entirely of glass was known in Swan's lamp, and in the same lamp the leading wires passed through the glass, and I believe the air was exhausted from the interior of the lamp.

At the date of Edison's specification do you know whether the word filament had acquired any technical signification?—Not to my knowledge in connection with electric lighting. The word had been used in various senses, but chiefly in botany, to describe the stem of flowers or anything that had a small cross-section and considerable length. A thread might be called a filament.

Referring to Cheesborough's specification, as a chemist would you say what substances are included under the words "infusible substances, non-conductors of electricity"?—Lime would be one, fireclay another, and many of the oxides of the metals, which would be properly described as infusible. Of course, all of them may be fused at a sufficiently high temperature, but they may be described generally as infusible.

The Court then adjourned for luncheon, and, on resuming,

Prof. FRANKLAND, in answer to Mr. GRAHAM, said: I was present when Mr. Crookes carried out Deprez's process, and saw the materials produced. I made an examination of those materials, and comparing them with the materials of Cheesborough's process I say they are identical.

Referring to the passage at the bottom of page 80, do you understand that to be an incandescent or arc experiment?—It is a little uncertain.

Coming to Sidot's process have you compared any of the carbons in the manner there directed?—I have.

What do you say of his carbons for incandescent lighting?—I say the carbons so formed are identical with the carbons produced by Deprez and Cheesborough's processes, and I say Sidot's filaments are well adapted for the manufacture of incandescent lamps.

Cross-examined by the ATTORNEY-GENERAL: You were examined, I think, at the last trial?—I was.

That was in the year 1886, two years ago?—I think so.

Since the last trial have you made any experiments yourself upon either of those two points?—No. I have seen platinum wires which have been carbonised along with the filaments in Mr. Crookes' laboratory, and upon the condition of those wires have founded my answers to-day.

Any information in the evidence you have given to-day is founded upon what you saw and observed for yourself at Mr. Crooke's?—Yes, it is, mainly.

Prior to giving evidence in 1886 you had made several experiments, had you not, in connection with the Edison patent?—Oh, yes, I had.

Where?—In the works of Messrs. Woodhouse and Rawson, manufacturers of incandescent lamps in a very large way at Hammersmith.

Did you say one word at the last trial as to the instructions to enable people to carbonise being necessary?—I have not my evidence before me, and cannot say.

Did you say one word directly or indirectly suggesting that the directions as to carbonising were insufficient?—I do not remember one way or another. Perhaps you will be good enough to point out in my evidence anything bearing on the point.

Have you read your evidence lately?—Not the whole of it, but a portion of it.

You have looked it through?—I have skimmed it.

You have no recollection of anything in it?—No recollection.

Did you say one single word about the porosity of the platinum wires?—No, I suppose I did not; I do not remember that point being raised.

Did you not say that with the directions none before Edison were sufficient to enable anybody to make an Edison lamp?—I daresay I might. I should say it now.

Did you consider that prior to the publication of Edison's specification the Swan lamp was the best embodiment of what was known?—It was an example of what was known, but it did not contain the best elements of what was known.

This F J B 1 Swan lamp was an exhibit at the last trial?—Yes.

It is a vessel made of glass?—Yes.

With a platinum leading-wire into the glass?—Yes.

Exhausted undoubtedly?—I have no doubt.

When did you first suggest that a lamp made like Swan's should have Sidot's filament in it?—I suggested it over and over again at the last trial.

Did you ever suggest to the scientific world, or publish in any way until you gave evidence at the last trial, that Sidot's filament could be put into what we call Swan's lamp?—No.

Did you produce at the last trial a filament made according to Pulvermacher's patent?—I produced a lamp in which there was a filament which had been made according to Pulvermacher's patent, but I did not see the lamp made, and I think I said so.

Who made it?—Professor Donkin, and part of the process was witnessed by another professional gentleman, but none of it by me.

You were endeavouring, were you not, to break down the novelty of Edison's invention?—No doubt.

Did you not say, giving evidence upon oath, that there were ample and sufficient directions in Pulvermacher's anticipations to enable people to make Edison filaments?—I do not think I said Edison filaments, but I will not be certain on that point. I know, however, I said there were ample directions in Pulvermacher's specification to enable fine filaments to be made.

And carbonised?—I suppose so.

Would it have been of any use at all for the purpose of breaking down Edison's patent unless it could be carbonised?—Oh, certainly not; but I did not see it carbonised.

I refer you to your evidence in the last case, and quote the following:—"I have myself made filaments by this process, which, I think, are fine enough for any incandescent lamp." Was that true?—Yes, certainly. I made several filaments by Pulvermacher's process, and exhibited them in court.

You mean, then, to represent that Pulvermacher's was an anticipation of Edison's invention?—As a tar putty invention only. The difference was in the quantity of pitch. There was more pitch in Pulvermacher than in Edison.

And you endeavoured to get a decision that Pulvermacher anticipated Edison?—I did not care anything about the decision, I gave my opinion when asked.

Will you tell me what information anybody in 1879 going to make a filament to be carbonised according to Pulvermacher had at his disposal which was not open to a man going to carbonise in 1879 after Edison?—Of course it was all open at the time of Edison, and it was open at the time of Pulvermacher, which preceded.

Did you mean the judge to understand that the man who came to carbonise with the directions open to him could not carbonise a filament?—No; I suppose I did not. I do not know that the point was raised at all at that time.

You were representing to the Court that with the then existing knowledge prior to 1879 of Edison's patent a man could carbonise a filament. What do you mean by swearing to-day that there is not sufficient direction to carbonise a filament according to Edison?—You are putting things to me which I do not think fairly apply to me. I do not think I said at that time there were sufficient directions.

Did you mean the Court to understand, when you were endeavouring to break down Edison's patent, that the directions previously were sufficient to enable people to carbonise, or insufficient?—I do not remember anything on that point specially. I never carbonised at that time, or saw carbonised, one of those filaments.

Pulvermacher's description was of an arc lamp?—Yes.

That arc lamp was composed of a core of carbon, and spiral of carbon surrounding it?—There were two things entering into its composition.

And in between a non-conducting material to prevent continuity of contact?—Yes.

The Court adjourned at four o'clock.

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THURSDAY, MAY 3.

The cross-examination of Prof. FRANKLAND was continued by the ATTORNEY-GENERAL as follows :

You had not finished telling us about Deprez's experiments ?—In these experiments of Deprez when the temperature was carried to an extreme limit soft graphite—*i.e.*, the crystalline form of carbon—is formed, marks upon the the paper, and is soft and friable. When, however, a more moderate temperature is employed, and the pencil of carbon is immersed, graphite is not formed, but carbon from the carburetted hydrogen is deposited within the pores and on the surface of the pencil, rendering the pencil smooth, and of a bluish-grey, and increasing its size. Further, the pencil becomes denser, harder, bright, and very solid, and Deprez informs us that this is the result of the deposit.

Re-examined by Mr. FINLAY : Deprez describes the coupling up of 600 cells of Bunsen's battery. He first of all says he sometimes arranged the 600 Bunsen elements in one series. That arrangement would give a very high electromotive force, which would impel a very heavy current through such an obstacle as a pencil of charcoal, and would consequently heat that pencil to a very high temperature. Then he describes other experiments in which these cells were coupled in six series of 100 cells in each series. This would reduce the electromotive force of the whole battery to one-sixth of what it was previously, and consequently the temperature of the pencil in proportion.

So far as your own experience of these Pulvermacher filaments extended, are there any points of difference you can direct attention to between them and Edison's putty tar filaments ?—Yes, there are two or three differences. Although the filaments are made of the same materials, the proportions of these materials are different. Edison makes his tar filaments with lampblack and tar, the tar containing certain hydrocarbons and pitch, whilst Pulvermacher describes a mixture of charcoal, tar, and pitch, consequently there would be a larger proportion of pitch.

Were these Pulvermacher filaments made by rolling or forcing through a die ?—They were made by forcing through a die.

You spoke of the lamp you got at the Paris Exhibition from Mr. Sprague, are there sufficient descriptions in Edison's patent for making such a lamp as that ?—Certainly not.

Mr. JUSTICE KAY : In what respect ?—In the first place, there are no directions by which a filament of such very fine texture can be carbonised. Secondly, the workman is directed to make a totally different filament than that which was exhibited ; he is directed to make a filament of great mass, in order that the temperature may increase and diminish gradually by alterations of the current, and he is to get this, as a rule, by winding the filament into the form of a close spiral, which shall have a very small radiated surface in proportion to its mass. He gets this mass either by coiling the filament in a very close coil, or by increasing the size of it, and making it porous. The exhibited lamp shows neither of these peculiarities ; it exhibits in relation to its mass a very extensive surface of radiation, and its mass is very small. In the third place, the filament is attached to the wires by a process not mentioned in Edison's specification.

Dr. TIDY, examined by Mr. FINLAY, said : I am Professor of Chemistry at the London Hospital, and Official Anylist to the Home Office. I have for some time past paid attention to the subject of electric lighting by incandescence. With reference to the process of Edison I have endeavoured to make filaments as described in his specification, with the exception of coiling round copper. I regarded the materials to be used as coming under two heads—1st class : wood, paper, and cotton thread ; 2nd class : tar and putty. As regards the first-class, I attempted to carbonise in a crucible as small as possible without any packing, the top fastened on with Stourbridge clay, and they all disappeared except a little ash. I put in nearly fifty, but the crucible was not very full. I then tried the ordinary method of using powdered carbon, and succeeded. Thirdly, I used sand, as suggested by Sir Frederick Bramwell, and again the filaments were burned up. In November, 1879, an ordinary intelligent workman would, in my judgment, most certainly not have understood the packing with carbon was wanted. The process of carbonisation at that time in use was that of carbonising wood for gunpowder manufacture. Skill in that process of carbonisation would not enable a workman to carbonise filaments successfully, because in the case of carbonising wood for gunpowder a certain loss was of no consequence. I was particularly struck in 1881 or 1882, when I first saw the process of carbonising filaments, shown me by Mr. Crookes, with the method of carbonising with the use of carbon. I tried the making of tar putty filaments ; the difficulty in making them was in the proper consistency. I adopted Edison's process precisely, igniting the lampblack first, mixing the ignited lampblack with the tar. Edison gives no directions as to the proportion. If you use too little tar the thing comes to pieces with the greatest ease long before you get what may be called a fine wire. If you use too much tar the thing runs, so that you cannot do anything with it. After a great many trials I got a wire of the material, I should say about $\frac{1}{25}$th of an inch—quite as small as I could get it—and that was obtained by rolling it on a glass plate, dusting the glass plate with powdered charcoal, and rolling on a spatula. I tried to make a spiral of it, but failed. I saw Mr. Crookes experiment with this and get a spiral. I cannot profess to have the extraordinary manipulative ability of Mr. Crookes ; he is almost unique in that particular. I then carbonised with packing of powdered charcoal, and it fell to pieces as soon as I took it out. The whole thing practically came to nothing. I am aware, in carbonising filaments, how moulds are employed. That is necessary for the process of carbonisation, or, rather, it is necessary to prevent distortion during carbonisation. I did not know the necessity for moulds myself in 1879—indeed, not till three months ago. I did not employ such moulds. I was following Edison. By the absence of such moulds the filaments were all kinds of shapes when I took them out. I should say they would not be useful commercially for making electric lamps. I never got a filament. I could have wound round copper. I tried the effect of joining the platinum and the filament before carbonisation. The effect was that the platinum was rendered more porous and a carbide formed. That is a reaction between the carbon and platinum, with which at high temperature I was perfectly familiar. I should judge that would have some effect on the platinum as to its suitability for a lamp. I tried the use of powdered camphor and oxide of zinc as suggested in Edison, with the result that it rendered the tar putty filament even more difficult to manage; it was not only more difficult to work to start with, but it was even more friable than the others, as I should expect. I never got a filament a quarter of an inch long, when I used those substances, to last after carbonisation. I ascribe that to the reducing power of the carbon on the oxide of zinc and the volatility of the metal. If the oxide of zinc was not reduced in the carbonising furnace, it was certain to be reduced in the lamp. I saw experiments by Mr. Crookes with non-conducting non-carbonisable substances, and quite agree with what he said about them. I have never known on the market for commercial purposes any lamp made under Edison 4,576. I could not even now make a practical lamp from Edison's description. As to Edison's second claim, assuming Swan's lamp, which I have seen, to have been made previous to that date, it combines all four details mentioned in that claim. I have seen the list of non conducting non-carbonisable substances, and in my judgment it embraces the substances which would be suggested by what is stated in Edison's.

Cross-examined by Mr. ASTON : My knowledge of the subject began about 1882. Prior to that time all I knew about carbonising was in connection with gunpowder. I had a good notion, however, what would happen to a thin filament of carbon put in a crucible and subjected to a high heat. I have known Sidot's process for some years. I should not think anybody who knew about Sidot would know about packing in charcoal. Referred to page 18 of Sidot and asked—Assuming that was known at the time, would it have guided an electrician workman to use packing ?

WITNESS : So far as that is stated there it would. The object of my experiments was to test Edison's directions pure and simple, and to test the method of doing it with the knowledge we have at the present day. I did get a thread the $\frac{1}{25}$th of an inch ; that was the smallest diameter. They were always breaking up or running off. Possibly differences of temperature would make the filaments less friable. I tried carbonising the filaments in sand, and utterly failed, getting a little ash only. According to the results I obtained a filament carbonised in sand would be destroyed by the oxygen in the air attacking the filament. That would be the same whether with bamboo, thread, or other substances. Shown a specimen, and asked if he believed it was a filament carbonised in sand.

Witness said he would ask all the details of the experiment.

Would you believe it ?—If you told me I would believe it (laughter).

Mr. JUSTICE KAY : I suppose you would want to know something about the nature of the filament.

Witness : I should like to know so many things (laughter).

Cross-examination continued : I know nothing about the means that could be employed for preventing distortion of the threads until three or four months ago. The filaments I obtained were all distorted more or less.

Is it not true that in all these cases, where you are obtaining experiments of this kind in order to obtain the most beneficial results, an experienced operator would very often be able to moderate imperfect results by altering your operations ?—No doubt.

Mr. JUSTICE KAY : That only means that if an experienced operator like Dr. Tidy went on operating long enough he might produce a result.

Prof. SILVANUS THOMPSON, examined by Mr. FINLAY, said : I am a member of the Society of Telegraph-Engineers, and of various physical societies here and abroad. I have for a good many years devoted attention to electricity and electric lighting by incandescence. I first met Mr. Stearn at Liverpool in 1877 at a meeting of the British Association. He exhibited the improved Sprengel pump, and I saw it. I visited his house at Rockferry in 1880. There were electric lamps in that house of which the globe was made wholly of glass, through which the leading wires passed and were sealed, and containing a thin conductor consisting of a carbon wire, and which had been exhausted. These were used all over the house for lighting. I was present at the British Association at York in 1881. A picture gallery there was lit up with Mr. Swan's lamps. These lamps were of the same kind in general as I had seen in Mr. Stearns's house. In 1881 I went to the Paris Exhibition, and saw the Swan lamps exhibited there. They were lamps of the same kind as the the others I have spoken of. I first saw an Edison lamp at the Paris Exhibition in 1881. I examined them as well as could be done without taking them into my hands, and afterwards I had an opportunity of examining closely lamps of exactly the same type. They were lamps which should come within the second claim, but with many subsequent improvements in their details upon the lamp described in the specification 4,576. [Shown FF 1. The lamp put in by Dr. Frankland, and which was similar to the lamps of which he spoke.]

Witness continued : The carbon conductor is more in accordance with Edison's latest specification, 578 of 1880, the paragraph beginning page 3, line 31, of the specification. As a second point, so far as I can judge, this conductor has been held in shape during carbonisation in the manner claimed in the subsequent specification, No. 3,765 of 1880, book 3, page 63, line 46. Third, the carbon conductor has its ends left apart, in the manner described in specification 1,918 of 1881.

The Court then rose for luncheon.

On the Court resuming, Professor SILVANUS THOMPSON, examined by Mr FINLAY, continued as follows : The clamp which holds the end of the carbon conductor is flattened in the manner described in the subsequent specification 2,492 of 1881. The joint so made has been electroplated in the manner prescribed in the subsequent specification 768, of 1881. Between the end of the carbon conductor and the platinum wire which is fused to the glass. there has been joined in a separate piece of

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wire, not of platinum, in the manner described in specification, 4,174, of 1881. The bulb has not been blown over, the rest of the lamp as described in Edison's specification, but has been separately made in accordance with specification 2,492 of 1881. The platinum wires that pass through the glass are connected to the terminals of another metal in the manner described in specification 2,492, of 1881. The lamp has been provided at its neck with collar connections in the manner described in specification 1,802, of 1881. This lamp has been heated during the process of exhaustion in the manner described in specification 562 of 1881. There are no other points occur to me at the moment.

By Mr. JUSTICE KAY: The intermediate wire is copper. The object of putting it in is for cheapness in economising platinum, and because it is easier to electroplate copper upon copper than to electroplate copper upon platinum. This connection is made after carbonisation.

By Mr. FINLAY: The exhibition of Edison's lamps at Paris compared very indifferently indeed with Swan's lamps. The hall was lit with a number of lamps—I don't think there were as many as forty—and the thing that struck me when I went into that room was that the light was very red, the lamps were bright red hot. I thought it a miserable exhibition in comparison with Swan's. Compared with the lamps I saw in Mr. Stearn's house, the lamps were larger in themselves, but were not run at such a degree of incandescence, they were more nearly red hot. The lamps were very effective in Mr. Stearn's house, and also at the *conversazione* at St. George's Hall, Liverpool. In November, 1879, electricians would be aware of the advantages of high resistance, so far as there are any advantages in it, but there are no advantages *per se*. The advantage of high resistance is entirely external to the lamp itself. It enables you, in the case where you wish, to distribute electric energy to a distance, whether for lighting or for motive purposes, to economise the cost of the conducting mains. I am acquainted with the carbons manufactured by M. Carré, some specimens of which I exhibit. I have not seen the process of manufacture of M. Carré's carbons, and know it only in general. In specification 792 of 1881 Mr. Edison refers to the commercial use of low-resistance lamps. I saw two safety lamps at Mr. Swan's, such as were exhibited at the British Association meeting at Birmingham; the lamps were of exactly the same shape, they burned perfectly well. I saw them run; they worked beautifully. I have given very close and careful attention to Edison's specification in all its features.

In your opinion could a workman of ordinary intelligence and skill, in November, 1879, have made an incandescent lamp from this description?—From this specification; certainly not.

Examination continued: In the first place the general tenor of the specification would mislead him as to the lamp that would be serviceable, and in the second place the lamp is never described. I have looked carefully through the whole of the processes described in the specification, and in my opinion they are insufficient. I have been familiar with the electric lamps that have been on the market for the last twelve or fifteen years and have never known one made under this specification. I do not find in this specification any description of what is intended by a filament. I always looked upon it as a new use of an old word to save long phraseology. I have examined most of the exhibits put in in the course of this case.

The Court adjourned till Monday next at 10.30.

MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-NIGHT) FRIDAY, May 4th.

SOCIETY OF MECHANICAL ENGINEERS.

7:30 p.m. Continuation of meeting at the Institution of Civil Engineers. Reading of Papers and discussion.

ROYAL INSTITUTION.

9 p.m. Lecture, "The Invincible Armada." By Prof. J. K. LAUGHTON.

SOCIETY OF ARTS.

8 p.m. Indian Section. "The Injurious Effects of Canal Irrigation on the Health of the Population of the Punjab." By Surgeon-General H. W. BELLEW, C.S.I., C.I.E. Sir JOSEPH FAYRER K.C.S.I., will preside.

SATURDAY, May 5th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Later Works of Richard Wagner" (4). By Mr. C. ARMBRUSTER.

MONDAY, May 7th.

SOCIETY OF ARTS.

6 p.m. Cantor Lecture VI. "The Decoration and Illustration of Books" (2). By Mr. WALTER CRANE.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at Westminster Hall. Paper on "Filtration by Machinery." By Mr. E. PERRETT A.M.I.C.E.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

TUESDAY, May 8th.

SOCIETY OF ARTS.

8 p.m. Applied Art Section. "The Decorative Use of Colour. By Mr. J. D. GRACE. Mr. E. C. ROBINS, F.S.A. will preside.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Plant in the War of Nature" (2). By Mr. W. GARDINER.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "The Distribution of Hydraulic Power in London." By Mr. E. B. ELLINGTON, M.Inst.C.E. Papers to be read with a view to discussion: "The Tay Viaduct, Dundee." By Mr. CRAWFORD BARLOW, M.Inst.C.E. "The Construction of the Tay Viaduct, Dundee." By Mr. W. INGLIS, Assoc.M.Inst.C.E.

ENGINEERING SOCIETY (King's College).

4:15 p.m. Paper on "The Forth Bridge." By Mr. GASK.

WEDNESDAY, May 9th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Locks and Safes." By Mr. S. CHATWOOD.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. General Meeting for presentation of Report, Election of Council, &c.

IRON AND STEEL INSTITUTE.
(At the Institute of Civil Engineers.)

9:45 a.m. Meeting of the Council.

10:30 a.m. General Meeting. Scrutineers will be appointed for the examination of the voting papers. Presentation of the Bessemer Gold Medal for 1388 by Sir Henry Bessemer, F.R.S., in the name of the Council, to Mr. D. Adamson, President of the Institute. A selection of Papers will be read and discussed.

THURSDAY, May 10th.

IRON AND STEEL INSTITUTE.
(At the Institute of Civil Engineers.)

10:15 a.m. Meeting of Council.

10:30 a.m. General Meeting of Members. List of Papers.—Adjourned Papers: 1. "On the Mutual Action of Sulphur and Silicon on Iron at High Temperatures." By Mr. T. TURNER, Mason Science College, Birmingham. 2. "On the Use of Water-gas for Metallurgical Purposes." By Mr. A. WILSON, Stafford. 3. "On the Imperfection in Mild Steel Plates, considered Chemically." By Mr. H. ECCLES, Port Talbot. 4. "On the Mechanical Apparatus for Continuous Moulding at the Works of M. Godin, Guise." By Mr. JAMES JOHNSTON, Manchester. 5. "On the Effect of Arsenic on Mild Steel." By Mr. F. W. HARBORD and Mr. A. E. TUCKER, Bilston. 6. "On the Manufacture of Ordnance at Trubia." By Major CUBILLO, Trubia. New Papers:—7. "On the Melting of Wrought Iron or Steel Scrap, mixed with Ferro-silicon, in Cupola Furnaces." By M. F. GAUTIER, Paris. 8. "On the Behaviour of Arsenic in Ores and Metals during Smelting and Purification Processes." By Mr. JOHN PATTINSON, Newcastle-upon-Tyne, and Mr. J. E. STEAD, Middlesbrough. 9. "On a New Instrument for the Measurement of Colour, more Especially as Applied to the Estimation of Carbon in Steel." By Mr. H. LE NEVE FOSTER, West Hartlepool. The Council have still to determine the order in which the Papers shall be read.

SOCIETY OF TELEGRAPH-ENGINEERS.

8 p.m. Meeting at the Institution of Civil Engineers. Paper, "On the Risks of Fire Incidental to Electric Lighting." By Mr. W. H. PREECE, F.R.S., Past President.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Chemical Arts" (5). By Prof. DEWAR.

SOCIETY OF ARTS.

2 p.m. Conference on Canals and Inland Navigation.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of April was 4,684, estimated to produce £3,700, against 3,823 messages, producing £2,964 in the corresponding month of last year. The traffic receipts for the month of Jaunary, estimated at £3,300, realised £3,355.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of April, 1888, amounted to £51,582, and to £43,136 in the corresponding period of 1887.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of April, 1888, amounted to £37,331, and to £35,955 in the corresponding period of 1887. Increase £1.376.

SOUTH OF ENGLAND TELEPHONE COMPANY (LIMITED).—The directors of this company yesterday declared a dividend of 6 per cent. per annum on the preference shares of the company for the half-year ending 30th April, 1888.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this company for the month ending 30th April amounted to £4,325.

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The Electrician.

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LIGHTSHIPS AND THE TELEGRAPH.

In the House of Lords last Friday evening the Earl of MORLEY directed attention to the question of electrical communication with lightships, reported upon by a Committee of the Board of Trade several months ago, and now being taken up again by the Associated Chambers of Commerce. Lord MORLEY himself does not go so far as some of the Chambers of Commerce, who are urging the connection of all the lighthouses and lightships with the Post Office inland telegraph system; and for reasons which were fully stated in these pages on the publication of the Committee's Report last September, that scheme cannot be entertained unless the Chambers of Commerce are prepared to take all the risks. The business derived from these sources would not be likely to repay the Post Office Telegraph Department for its expenditure in laying and maintaining the necessary cables. It rests, therefore, with the trades concerned —chiefly the shipping trade—to determine whether the commercial advantages to be gained, added to the revenue to be derived from the signalling of shipping intelligence, would warrant the outlay. On this point they appear not yet to have made up their minds, and Lord MORLEY is not able to assist them. For his own part he would have the electrical communication established round the coast if only for the purpose of saving life at sea; and he adduced some fresh evidence to show that the means suggested would be far more effectual to this end than the testimony given before the Committee seemed to indicate. It will be remembered that the Board of Trade's inquiry was confined to the Thames and its approaches, and directed mainly to the experiment at the "Sunk" lightship, which had been electrically connected with Walton-on-the-Naze in the previous year. It is now pointed out that this is by no means the most dangerous part of the coast, nor the one where the

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service of the telegraph or the telephone would be of the greatest utility.

The only reason discoverable for the selection of this particular area for the experiment was, not because of its special fitness, but because of the existence of a special fund, called the "Mercantile Marine Fund," from which the expenses could be defrayed. This fund happens to be applicable only to what is technically included in the designation "Thames," and of the twenty reasons or thereabouts which the Earl of ONSLOW assigned for not yet extending to other lightships the advantage of telegraphic connection which has been enjoyed by the "Sunk" since March, 1886, the one that had evidently most weight with him was that the fund referred to is exhausted. Such is the poverty to which this nation has been reduced that we would fain resort to the Mercantile Marine Fund if it could be legally diverted from its legitimate purpose, and if, indeed, any of that fund remained. But it is already exhausted, and, like the memorable excuse for not firing a Royal salute, this one of having no money to spend is as good as that of having no ammunition to fire. The fund at its best is a very small one, and has already had to be assisted by considerable loans. How, then, is it possible to extend these experiments, however desirable their object may be, when all the money is spent?

As to the remaining and superfluous reasons for doing nothing assigned by his lordship. most of them were erroneous, and some of them were even foolish. The experiment at the "Sunk" lightship, so far from being comparatively unsuccessful, has decisively proved the practicability of permanently attaching a submarine cable to a floating lightship which, though moored, is shifting. If this particular telegraph service has not yet forestalled the rocket signals for the several cases of distress in its vicinity occurring since the cable was laid, the fact speaks well for the clearness of the atmosphere on those occasions, but detracts nothing from the potential value of electrical signalling for foul weather. And on some parts of our shores, notably on the Irish coast, the lightships, and consequently most of the passing vessels, are cut off from the shore at night by impenetrable fog. This, at all events, is very generally the case; and it would not be difficult to mention many other points of danger where direct and instantaneous communication with the shore would frequently save precious time, which in this relation means human life, by indicating when and where succour is needed. There may be good and sufficient reasons for not extending the "Sunk" lightship experiment all round the coast indiscriminately; but to allege as a reason for not extending it anywhere the impecuniosity of the Mercantile Marine Fund seems to us utterly unworthy of a country whose shipping trade and whose national resources are equalled by no other country in the whole world.

Against utilising these lightships as signalling stations for the purposes of commerce it has been urged that their security would be jeopardised by the approach of the trading vessels desirous of sending messages. We owe this argument to the Board under whose care all the lighting of the coast is placed; and from the point of view of the caretakers it is properly put forward. But when fairly examined from the users' point of view the objection cannot be taken very seriously. Lightships, of course, are beacons of warning, not places of converse; but their character would not be altered in the former respect, it seems to us, if they served on occasion the purpose of the latter. In fair weather they could be approached near enough to be communicated with; and in bad weather we may trust the captains to run no unnecessary risks. It may be admitted, however, that some uncertainty and conflict of opinion exist as regards the two objects for which these coast telegraphs have been generally advocated—one as an aid to the lifeboat service, the other as a purveyor of shipping intelligence. The utility of both are questioned from two opposite quarters; but probably because neither wishes to bear the whole expense of the undertaking. One other object would be served, not mentioned in the discussion on Lord MORLEY'S motion, namely, that of supplementing the coast defences of the nation. Possibly these three interests may some day come to an understanding mutually advantageous and helpful, so that the cost shall be divided among them. Their destructive criticisms would then cease, and we should expect to have a complete system of coast telegraphs in full connection with the inland system.

THE NEW CABLE STEAMSHIP "AMBER."

The new telegraph cable steamer "Amber," the fifth vessel of its kind for the Eastern Telegraph Company (Limited), has been built and engined by Messrs. Robert Napier and Sons, of Govan, Glasgow. She left Gravesend on Saturday last for Cadiz, and is now employed on some cable work there.

The "Amber" is the smallest vessel of the Company's fleet, but owing to the engines having been placed in the after part of the ship, thus leaving available the best part of the ship for cable tanks, saloon accomodation, berths for officers and crew, the ship is rendered thoroughly efficient for any description of cable repairs required.

The dimensions of the steamer are as follows:—Length 210ft., breadth 31ft., depth 24ft., her builder's tonnage being 978 tons, net register tonnage 557 tons.

Being built for an awning deck (class 101 A 1 at Lloyd's special) she has an uninterrupted deck fore and aft, with head and stern sheaves, giving every facility for the work in which she is to be engaged.

The vessel is wholly built of steel, and all the most modern appliances have been adopted, including steam steering-gear; the engines are triple expansion, the cylinders having a diameter of 19, 30, 46, by 36 stroke, pressure 170lbs., driving the ship at a speed of 13 knots on an easy consumption of coal.

The cable gear is the design of Messrs. Latimer Clark, Muirhead and Co. (Limited) on the tandem principle, driven by two separate engines, which can be united together and exert either their full power, if found necessary, on either of the drums, or can be separately used on one or the other drum independently.

The electric lighting and search lamp is by Messrs. Johnson and Phillips, of Charlton, Kent.

The saloon is amidships and is very tastefully finished, being enamelled white and gold.

The wood-cut on the next page will give a general idea of this ship, which is beautifully lined. It is the third ship of its kind which has been illustrated in these pages. One was the "Magneta," a full description of which we gave in our issue of 3rd January, 1885; the other was the "Electra," given on the 7th of the month following, the cable gearing of both of which vessels was manufactured by Messrs. Johnson and Phillips.

The dimensions of the "Amber" are rather less than those of the two vessels just named, each of which were 230ft. in length and 32ft. in beam, their (builder's) tonnage being 1,096 tons. The "Amber's" depth, however, is the same as her predecessors'.

It will be remembered that the "Magneta" was lost, with all hands, about three years ago; and the new steamship "Amber" has been designed to take her place. The "Amber" is fitted with all the latest and most approved appliances for cable laying and cable repairing, and is, it may be said, the outcome of the varied and wide experience which the owners of these vessels have gained in their important operations.

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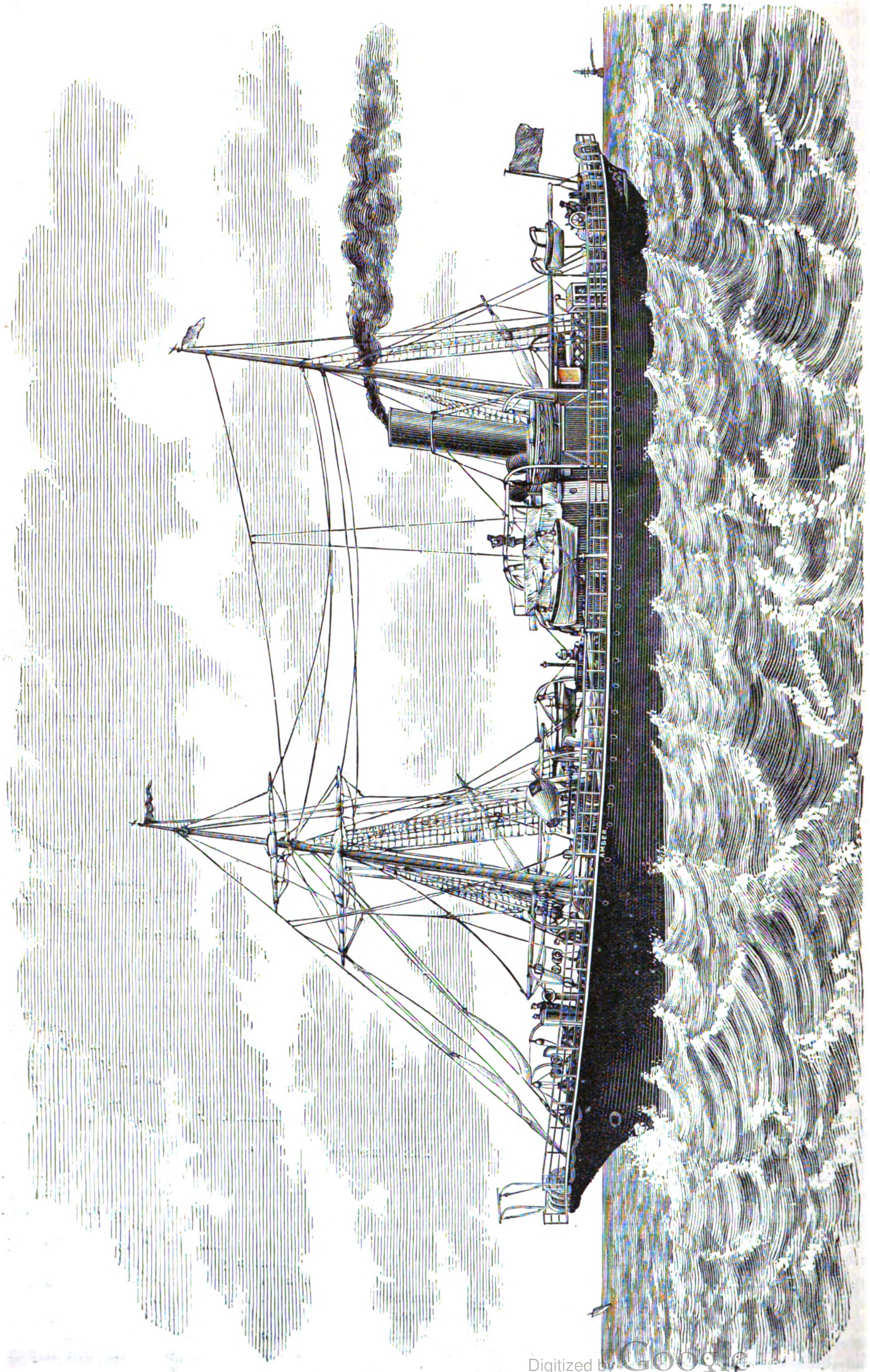

THE NEW CABLE STEAMSHIP "AMBER."

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SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

CENTRAL STATION LIGHTING.—TRANSFORMERS v. ACCUMULATORS.

On Thursday, April 26th, the Society met at the Institute of Civil Engineers to resume the discussion on Mr. Crompton's Paper, the President (Mr. E. Graves) in the chair.

(*Resumed Discussion on Mr. Crompton's Paper, from page 698.*)

The PRESIDENT announced that Mr. Crompton could not be present until the 17th May, and they proposed to close the discussion that evening and hear Mr. Crompton's reply at their meeting on the 17th May.

Mr. ESSON then resumed the discussion. He said Mr. Crompton's Paper ought to be a valuable one, inasmuch as it professed to deal with the facts and figures contained in actual working; he could not help thinking at the beginning that it would be much more valuable if Mr. Crompton had confined himself solely to the figures obtained at Vienna, not to figures extracted from a hypothetical case, which he had not yet carried out. It was of great interest to know precisely the return which was obtained from accumulators, and as far as he knew those results were not higher than 60 to 61 per cent. With respect to the total working expenses, he thought there might be very little to choose between the transformer and the secondary batteries; but until they had the actual figures obtained from an alternating transformer system all their estimates must be very much of the nature of a speculation. He wished that some gentlemen who were specially interested in alternating currents would show their coal bills—that is to say, if they had them with them (applause). As regarded the reliability, he did not think that there was, on the whole, much to choose between the two systems. As far as the generating station was concerned, he placed as much faith upon the alternating-current system as upon the accumulator system. But when they came to the question of mains they had a somewhat different subject. When they came to the general system of distribution, where they had very complicated conductors, he should view with distrust any scheme which placed a network underground at a potential of 2,000 volts. Of course they had very little experience of the behaviour of conductors underground when fed with such high potentials, but such experience as they had certainly tended to make them distrust the effect which was said to have been produced. It seemed that if they were to have safety they must have a few large transformers to distribute the current at a few hundred volts; and when they did that they came to much the same thing as was the case with Mr. Crompton. The transformer stations, and the cost of distributing mains on both sides, cancelled out, and the only difference was the cost of charging mains for 500 or 2,000 volts.

Prof. FORBES, who was received with much applause, said: I think that the Paper which has given rise to this discussion is of a character which ought not generally to be read before the Society. I think it is unfortunate that a Paper should have been given to us on what is purely a hypothetical case. I think we ought generally to deal in our Papers with accomplished facts as much as possible, and in the case of installations that we should have the actual results from practice; and I consider that the discussion which this Paper has given rise to is probably the more valuable part of it, although the discussion has extended itself beyond the scope of the Paper, and has become a general discussion of the distribution of electricity. I am very sorry that Mr. Crompton is not present, because there are several things which I should have particularly wished him to have heard, and especially these introductory remarks of mine. I think it is extremely unfortunate that he did not give us a Paper upon the two installations which he tells us have been so successfully worked, and which would bear out the results of the Paper itself, viz., the Vienna installation, and another one which he has at Kensington. He would have been able to give us some information about the action of the accumulators which have been used in those two places, about the amount of current that was put into the accumulator and taken out, and a great deal of information which would have been very valuable to us. We want some detailed information about the Howell accumulator. It is all very well for him to say to us that we may see the Howell accumulators, that we have every facility of examining them, and of going to Kensington any evening we please and seeing them working. I, for one, have not been able to determine the value of an accumulator by seeing it simply in a central station and examining it at work (applause). Mr. Crompton states at the beginning of his Paper the object for which he has written it. It is to support an assertion which he had made on a previous occasion, to the effect that "I believed the distribution of electricity by transformers offered no special advantages over other methods." And then, instead of discussing the various methods which might be used in preference to transformers, he selects one (as it happens, the least advantageous one he could have selected), that of an accumulator. In this particular case he has not proved the assertion that he made before, that transformers have no special advantages over other methods, because he has taken a single case, a case of a small station of 10,000 lights, with 2,000 yards of charging mains. I say even if he proved his case with that, where the transformer was not specially eligible, he would not have proved the case where transformers are specially useful. Now, in the special case which he has taken, I think it would have been much more natural that he should have taken some other system of distribution. There are numerous other systems which he might have adopted and gone into, and there is no doubt in my mind what system would have been found the most economical, and which would have been far cheaper than the transformers and than the accumulators, and that is the system Mr. Stanley has lately completed in America, and which I find has been noticed in this Society in Mr. Mackenzie's Paper on transformers. As an example of the cost of different systems of distribution, I may mention that a couple of years ago, after I had published my theoretical work on the distribution of electricity, I took a special district of London, the club district of Pall Mall and St. James's, and got information from the secretaries of those clubs as to the length of hours of lighting in different rooms, and the number of lights in each room, and other data, and I then devoted a considerable length of time, with the assistance of Mr W. H. Snell, who was then in my office, taking out the cost of the different systems. I simply mention the results:—The simple parallel system costs per candle-power per annum 2s.; the three-wire system, 1s. 10½d.; the multiple series system, 1s. 10d.; the same system when complying with Board of Trade requirements, 2s.; Bernstein's series system, 1s. 10¾d.; secondary generators, 1s. 11½d.; secondary batteries, 2s. 4d. The price of secondary generators has been reduced since that date.

Mr. Crompton gains very little by putting his batteries in series. He gains in the cost of the 2,000 yards of charging main, but nothing on the cost of the 20,000 yards of distributing main. This small gain is not an equivalent for the inconvenience of introducing 480 volts into houses. Our president has said that our time is limited, and I do not think that it is worth while devoting very much time to the figures which occur in Mr. Crompton's Paper.

The chief points in his Paper are the two tables—the cost of installation and the cost of maintenance, and I will say a few words on these. In the first place, in Table A, we find that there are 600 kilowatts required as a maximum. Now, from the remarks which have been made by gentlemen here, I fancy that it may be of some interest if I illustrate my remarks on the Paper by the practice in America, which I have had very considerable opportunities of examining in all its details within the last few months. Now, it is found most positively that the return of the transformer system, which is used there by Mr. Westinghouse, enables us to get from each horse-power 600 watts in the lamp for the indicated horse-power (applause). Mr. Crompton for a 600-kilowatts station has demanded 1,450 horse-power instead of 1,000 horse-power—that is to say, he has added as a reserve 50 per cent. of what is actually required at a maximum. We also find generating station buildings, chimney shaft, water tanks and general fittings £11,000, which he has apportioned to his 1,450 horse-power, on the alternating-current system, while to the accumulator system he has apportioned only £8,000. A reduction will take place there also. The cost of dynamos and exciters is perfectly correct. In accordance with American figures, the price which Mr. Crompton has given us would approximately include everything in the station, including the station switches, resistance boxes, voltmeters, ampere meters, lightning arrester, ground detector, compensators and synchronisers, with spare armature ball bearings and brushes. These are all included in that figure. The price of transformers is given by Mr. Crompton at £7,500 instead of £4,000. The mains are the point in which Mr. Crompton makes the greatest error. He has failed to appreciate the value of the transformer system in saving the cost of mains. In most systems the mains being massive must go underground. But with the maximum current of 300 amperes required in this station on the converter system, they ought to be overhead wires, which reduces the cost enormously. If we were dealing with a station of 100,000 lights, Mr. Crompton will see from his table that the cost of mains does then become almost exactly proportional to the weight of copper, and here the converter system again maintains its superiority. I therefore reduce Mr. Crompton's estimate for mains to £6,000. Having made all these corrections to the estimate for the converter system, it is reduced to £34,140 instead of £57,440. Hence the relative cost of converters and accumulators in the unfavourable case chosen by Mr. Crompton is £34,140 to £59,652.

Having pointed out the source of error in this estimate when dealing with the alternating-current system, I now point out one source of error in connection with the accumulator system which is sufficient to throw doubts upon the accuracy of these results. I speak of the efficiency of the accumulators. You will find that he tells us near the end of the Paper what is the efficiency of the whole system; that is to say, the combined efficiency of the conductors and the accumulators, including both of them. He says:—"For the output of 2,100 units it will be sufficient to work the generating plant for about five hours at approximately its greatest rate of efficiency. I have had ample experience with this class of plant, and know that we can in actual practice produce the E.H.P. at the terminals of the dynamo with the expenditure of 3½lb. of coal." Good—granted. Then, "taking the maximum loss in the accumulators, the efficiency of the system—that is, the E.H.P. at the lamps divided by E.H.P. at the terminals of the dynamo—will not be less than 80 per cent." "Therefore," he goes on to say, "we may say that each unit at the lamps can be produced for 5·75lb." Three and a-half pounds of coal for the work given out at the terminals of the dynamos, and only 20 per cent. on this for the loss in conductors and accumulators. Now, he has told us in his Paper that in his conductors, while admitting the loss of 10 per cent. in his charging mains and 4 per cent in his distributing mains, that comes to 14 per cent.; as a matter of fact, I have worked it out, and I find that his charging mains have a loss of 12 per cent., instead of 10 per cent. That would make 16 per cent. altogether, but I do not know how the distributing mains are worked. That is, 16 per cent. out of the 20 per cent. is due to the charging mains, and 4 per cent. loss of efficiency in the accumulators during the five hours, when he says the generating plant is working at its greatest output. That is to say, he employs accumulators which are giving an efficiency something like 96 per cent. He tells us the average rate which the accumulators have to be able to

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discharge. The cells while discharging normally at the rate of 416 amperes are to be able to go on discharging at that rate for five hours, giving a capacity of 2,080 amperes; but while their normal discharge is 416 amperes are to be kept at a rapid discharge at an efficient rate of 1,352 amperes. In his final table of the working of the accumulators, he gives us the depreciation of accumulators, and he puts it down at 15 per cent. as the working of accumulators. We know of no accumulators that will work at that rate of maintenance. I know this, from the experience of Mr. Preece, who told me the other day that in his accumulators, which had been carefully watched, out of 16lbs. of active material there is 1lb. lost in the first year. Now, finally, in his estimate for the cost of these cells he tells us in order to make his system effective he must take a cell which will normally discharge at 416 amperes for 5 hours, which will have a possible rate of discharge of 1,352 amperes, which will give an efficiency of nearly 95 per cent., and which will have a depreciation of only 15 per cent, and that he will get these cells for £40 a piece. Now I have said that it would have been better if Mr. Crompton had given us the results of his own experience with accumulators at Vienna and at Kensington, and I am perfectly certain that the result would have been totally different from that he has claimed here. I am very sorry to find that Mr. Crompton should have made a statement in the first page of his communication to the effect that the experience which has been gained in America and in other places with the alternating-current system does not help us much in our investigation. I say that it would help us infinitely more than any number of Papers he might have laid hands upon. In the few months that I have been studying the system practically in the States I have gained more information, such as is applicable to Mr. Crompton's station, than reading the Papers of all who have written in this country on the subject. I wish to refer to one point before I leave the question of these estimates. Mr. Crompton has stated that a great deal of nonsense has been talked about the cost of conductors in proportion to the cost of copper, and I daresay a great deal of nonsense has been talked. I do not remember particularly, but it is quite possible that there has. But do not let us have any more nonsense on the subject (laughter). Mr. Crompton says that these tables are sufficient to show that we must have considered the cost of repeating the conductors as in any degree proportionally to the cost of copper. I say that in overhead wires you must consider that it is so; and while I would not wish to see overhead wires laid in a really large installation, still in small installations of 10,000 lights I think that they ought to be laid; but what we want to see, at any rate in this country, is a sound installation of a large number of lamps. In most of my observations on the distribution of electricity I have generally dealt with the installation of 100,000 lamps, and that is a likely size for a town with a population of four and a-half millions. Now look at the dimensions of the cables, which he gives in table No. 2. He maintains that the cost of laying them is out of all proportion to the cost of copper, but when you come to 2 5 square inches section and three inches section you will find that the cost of laying has become gradually small—very small—in comparison with the copper, and the total cost is nearly in proportion to the weight of copper. And when you come to cables for 100,000 lights we may take it as absolutely assured that the total cost of cable laid is about proportional to the cost of copper. Here, sir, my criticism of Mr. Crompton's Paper ends. I had thought since the discussion had generally gone to the distribution of electricity that possibly you would like to hear something about the alternating-current system as used in America. I intend to give somewhere or other a full account of that system as used in America; but I had thought some little account might have been interesting here (applause).

Mr. PREECE hoped that Prof. Forbes would give them five minutes of his experiences in America (applause).

Prof. FORBES: I will give you one fact first, which has some bearing on the figures in Mr. Crompton's estimate, and that is the station attendance—the cost of keeping up a station in America. That was the thing that struck me more from a commercial point of view than anything else—the small number of men and the small amount of labour and supervision required for a station. Denver has a capacity for 7,000 lamps. It employs one manager at 150dols. a month, a secretary at 80dols. a month, and an office boy. It has two dynamo attendants at 70dols. each, and two engine attendants, five firemen, and two inspectors, who go over the lines and repair them. That is the total staff for the Denver installation of 7,000 lights. That is a station where coal is used. In several of the stations which I visited—for example, at Pittsburg and Allegheny and East Liberty—coal is not used. Going into the boiler room, you wander about, and the first thing that strikes you is why is nobody here, and you find a moody, melancholy man sitting reading a newspaper, who is attending to the whole of the boilers for a 10,000 plant. The furnaces are fed in this case by the natural gas. Natural gas and the air are let in through pipes controlled by a valve, the valve is controlled by the pressure in the boilers, and the boiler attendant has simply nothing to do. The pressure on the boilers is able absolutely to control the gas and air. The engines of the alternating current have been Westinghouse engines, which although fairly economical in steam, are not very economical; but they give very little trouble. Small engines are always used in central stations—not less than four of them—driving the dynamos by belt direct. The largest engines work up to about 250 horse-power. There can be no doubt that it is a mistake to put down one large engine to do the variable work in a central station. It cannot be economical in coal consumption. Mr. Westinghouse has nearly completed a rotary engine for working his dynamos direct, and he hopes for a high economy from them.

The alternate-current dynamo machines which are used in the States are totally different from what have hitherto obtained as the type of dynamo in this country. I do not know what progress has been made in the last three months, but I presume that the alternating type of dynamos, which were favourites lately, are now given up. Those were armatures such as those of Siemens and Ferranti. The Westinghouse armature has plenty of iron in it. It has been frequently described in this country. It is a drum armature, made of thin iron discs. The wire is wound round strips of wood, which are laid longitudinally on the periphery of the cylinder. The number of poles is 16 in the large machines, and they work at the rate of 1,000 revolutions per minute. The discs forming the armature are punched with six holes to lighten them. Still, the armature is heavier than necessary. The machine is mechanically good, strong, and substantial, with every part machine-made and interchangeable. The heating is very small. The exciting power is 2 per cent. of the total power generated by the machine. There are only three types of machines made—650 lights, 1,300 lights, and 2,600 lights. The resistance of the armature of the large machine is 0·15 ohm. Its weight is about 18,000lb. There is one defect in the machine, namely, the sixteen useless wireless surfaces on the periphery of the armature. One would naturally suppose that these spaces on the armature ought to be filled by iron like Pacinotti teeth; but there are great mechanical difficulties which would increase the cost of manufacture to a great extent. I have suggested (and I believe the suggestion is going to be adopted by the Westinghouse people) that this vacant space should be utilised by making a complete additional set of windings on the unused parts, which will form a separate circuit, and be a quarter of period behind the phase of the other winding and will supply separate feeders. In that way the capacity of the dynamo, though very good in itself, will be increased something like 25 per cent. or 30 per cent. (applause). With regard to alternate-current machines, I should like to throw out a suggestion that the most efficient type of the machine of the future seems likely to me to be a different type to those which have been hitherto adopted. Most of us have been interested in the progress of Mr. Parsons' turbo-electric generator. That engine is made to consume only 39lbs. of steam per horse-power per hour, and it may be improved so as to be an economical engine. The large-sized machine of 300 amperes and 80 volts runs at 8,000 revolutions per minute. I have suggested, first of all to Mr. Parsons, and he has undertaken to act upon the suggestion, that he should take his commutator, and put two rings around it, connected one with one bar of the commutator and the other with the opposite bar, leaving a small space on the commutator to take off a continuous current to feed the field-magnet. Brushes will collect an alternate current from the two rings. Since the speed of revolution is 8,000 revolutions per minute, that means 16,000 alternations per minute, which is exactly the number used by the Westinghouse Company.

One has heard a good deal about converters. I have recently had an opportunity of testing converters at Pittsburg, and I adopted the same method as Prof. Ayrton described—that is, the calorimetric method which was first used by Ruiti. I adopted the form of experiment suggested by Prof. Ayrton, and I made some careful tests, and the most important result which is arrived at is that in his No. 6 converter (which is a 30 light machine), with a half load, I got 95 per cent. (applause). I shall conclude my remarks by just saying one practical word about the manufacture of dynamos and converters at the Westinghouse establishment. There are only a certain number of types made, only three types of dynamos, and only five types of converters; and that is absolutely essential to the success of manufacturing for a large sale, and to supply the public at moderate prices. It was quite sad to me to remember and think of our manufacturers when an order is sent in to them. They are told the number of volts and amperes which the manufacturer has to provide for. It is ridiculous to expect to get economical dynamos in this way. It is only by doing the manufacture on a large scale that we can get things at a cheap rate. To make a single converter at Mr. Westinghouse's factory, about ten different machines have to be employed which are extremely costly to make; but each of these ten machines is able to turn out 50 to 100 of the parts of the converter with which it has to do in the day; and therefore, by having these machines ready to construct always exactly to scale, Mr. Westinghouse is able to produce them at an extremely low figure. This is a successful plan from the manufacturer's point of view, which I should urge on the manufacturers of this country. There is an important fact from the user's point of view, that the parts of such machines are all interchangeable and to scale. If your dynamo armature gives out, you simply telegraph, for example, for a No. 3, and it comes by the next train, and so on with every other part that is required. I have a few specimens of some of the smaller parts of the Westinghouse distribution apparatus on the table—switches and cut-outs and things which may be interesting to some.*

Mr. J. E. H. GORDON: After we have listened to Prof Forbes's most interesting speech we feel that our friend Mr. Crompton, if he were here, ought to feel himself very much pulverised; but no doubt if he were here he would have a different view. Much has been said, not only by Prof. Forbes, but by other speakers, about the disadvantage of not being able to obtain any accurate figures about accumulators, and perhaps a few notes which I have of results from actual contracts may clear up some of these points. Before going to these notes, however, I would like to say a word about the diagrams that Mr. Crompton showed last week, and in which I feel some personal interest, because I was, I think, the first to show them to the Society. There is one load diagram for London and two for America, and I want you to see how extraordinarily accurate they are, and this is shown by the trifling difference between them. In the London diagram the peak comes at seven o'clock, at Boston it is a little after half-past five, and at Cincinnati it is a quarter to six, which quite illustrates the fact that the average time for dinner in America is 1½ hour earlier than in London; thus there is a

* See illustrations on page 752.

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coincidence which goes a good way to show that the diagrams are most accurate. Really the stars in their courses seem to be invoked by Prof. Forbes to fight against the accumulator system, for not only has it its inherent defects, but overhead wires are to be laid for the transformer system alone, which I believe are not going to be laid for anything else. We are hoping to get rid of overhouse wires, but they are stated to be necessary for the success of the transformer system on a large scale. Then we are to have a Government which is to allow us to use 2,000 volts alternating, but only 400 volts direct. Then we are to omit all spare gear in order to keep the capital cost of the transformer system down. I have had a little experience in working without spare gear. At Paddington we have 50 per cent. spare gear; but we had a law suit, and had to make some alterations in the machines one by one, and for five months we had no spare gear. Nothing happened, but there was a great source of indirect expense due to what I might call the depreciation rate of the engineers, which gets very high indeed when there is no spare gear. In fact, I think that if we were to go on much without spare gear, as the industry develops the depreciation of engineers will go on at such a rate that we shall soon have no engineers at all. I have no interest whatever in any battery or other electrical apparatus at this moment, I only go to the best maker for the articles I contract to put down, and I can speak on the subject, perhaps, in a way that Mr. Crompton could not. I will give you some details of the Howell cells—details taken from a contract signed between Mr. Crompton and ourselves, dated December 22, 1887. The contract is to supply us with 492 cells—that is, 8 batteries of 50 cells each, and 12 spare ones (for 110-volt lamps), and the contract price is £3,320, or £6. 15s. per cell, or £27 for four of these cells, which are equal to one cell of the size referred to by Mr. Crompton, against £40 quoted by him. Here I acknowledge that Mr. Crompton has made an error, for he has put the cell at £40, and supplies me with four quarter-size cells equal to it at £27. The normal discharge of this quarter-cell is 105 amperes, the capacity is to be 525 ampere-hours; at the end of such discharge the cells are not to be so exhausted as to cause undue waste when recharging takes place. The next clause (I am quoting an abstract of the contract) provides that the cells are to be capable of discharging at the rate of 200 amperes, and under those conditions they are to have a capacity of 375 ampere-hours. The efficiency at 105 amperes discharge is to be not less than 75 per cent.; the efficiency at 75 amperes discharge is to be not less than 85 per cent.; at 45 amperes discharge it is to be not less than 90 per cent. I must remind you that in practice, although we have a large discharge for a short time, the bulk of our work is low discharge for the longest hours. The cells are to be delivered fully formed. If when the cells are put up the capacity of the cells is not up to the mark, Messrs. Crompton have at their own expense to supply as many extra cells as may be necessary to bring up the total capacity of the battery to that specified for the 480 working cells, so that if the capacity is one-half they must supply as many cells again.

Prof. FORBES: Is there anything in the contract about depreciation?

Mr. J. E. H. GORDON: I am coming to that. If the efficiency is not up to the specification, Messrs. Crompton must at their own expense supply as many extra cells as may be necessary to reduce the discharge per cell to such an amount as shall bring the efficiency up to the contract figure. As to depreciation, Mr. Crompton has here said that he hopes to do it for 15 per cent. His contract with me is for five years; we are bound only year by year—that is to say, as long as we choose we can compel him to keep the cells equal to new for this rate; but if ever we find that we are paying too much, and prefer to do it ourselves, we can stop the contract. He contracts to keep the cells in all respects equal to new for a payment of 12½ per cent. on the contract price, not 15 per cent. or 40 per cent either.

Mr. R. P. SELLON said he was sure they had all been extremely pleased to get from Prof. Forbes some figures on the alternating current in the United States; but the Professor took exception to some facts in Mr. Crompton's Paper, and he criticised his figures so unfavourably that alternating currents were made to appear relatively far more economical than the batteries themselves. First of all he said that in the United States mains were allowed overhead. The Professor therefore thought Mr. Crompton's was an extraordinary large figure for the alternating-current mains, and that they should be cut down to something very much less. He was himself in the United States not many months ago, and he was perfectly certain that through the length and breadth of the United States the alternating-current distribution was carried out by means of overhead mains; but the Yankees would accommodate themselves to circumstances in a way that would not be tolerated in this country. No sane electrical engineer would attempt to lay an installation of 100,000 lights with overhead wires. The moment that they took into account that their mains were going to be laid underground that brought them to this point: that they were in absolute ignorance of what the working of high-tension alternating mains would be when ramified right and left underground. The company to which he (the speaker) belonged had had more experience with high-tension currents probably than any other company in this country, and if they were to judge from the experience that they had had with continuous currents, with 2,000 volts underground and only relatively to a few miles, when alternating-current distribution came to be carried out with a transformer in every house and 2,000 volts laid on, as they said in "John Gilpin," "May I be there to see" (laughter). But what were the objections raised to batteries? As far as he was aware it was this. The secondary battery up to the present had received a very great deal of odium, for this reason: In the case of dynamo machines, or anything else, when an instrument got wrong it let them know—"greased lightning" was seen in a general way (laughter). With batteries they might have a totally different state of affairs. These batteries bore their sufferings meekly, and what was worth so many thousands the night before the following morning had resolved itself into the value of lead. To that fact it was that batteries had up to the present fallen to a great extent into disgrace. The workman had relied upon the fact that these batteries would not complain—he had seen nothing going wrong, and the battery did not change colour, and he supposed that it would be all right (laughter). When they came to distribute in practice on the lines which Mr. Crompton had advocated, and which he (the speaker) imagined every sane man would advocate, namely, distributing from local centres, that difficulty would be entirely removed. The batteries would be placed under the care of somebody who was competent to attend to them; and under these circumstances the main objection, as he understood the matter, to secondary batteries would disappear. There was one point that he should like to ask Mr. Crompton with reference to his Paper. His figures were based upon 400 volts as the E.M.F. of supply—that was for the distribution of 10,000 lights-that was four centres with 2,500 lights each. As Prof. Forbes had stated, the question was not one of 10,000 lights, but 100,000 lights, and when they came to that state of affairs, what was Mr. Crompton going to do? Was he going to increase the number of local centres from a single source of supply and place them in series, or was he going to have a secondary set of main generating stations for every four sub-centres? If he was going to put a larger number than four local centres in series on a single source of generation, the total difference potentially would rise. Under these circumstances the danger arising from leakage, and the inconvenience arising to the householder, would be so great that he must have two sets of batteries, and he must have them split up into two halves, and charge one half while the other was discharging. That involved that the charging should not be on at the same time as the discharging, and the two batteries would have to carry out the whole discharge between them, and therefore the bulk of the battery must be sufficient to meet the demand. If he took the alternative, and did not place more than four local centres on the main generating plant, there again Mr. Crompton met with what certainly modified his figures; and under either alternative, when considering the question of the distribution on a large scale, he must be prepared to modify his figures. To his mind the idea of distribution for the future was really one in which continuous-current transformers and batteries formed the source of supply (applause). Under such circumstances as those the procedure would be this: during a few hours of maximum demand their continuous-current transformers and batteries would go on supplying the current; while about one-half of the time their whole plant would be in operation, but there would be a surplus current supplied which would go to charge the batteries. During the period of medium demand, which would be one-third, say, of the whole 24 hours, their accumulators alone would supply the necessary current. Such a system as that met the objections to both systems which were the subject of Mr. Crompton's Paper. They obtained the advantage of storage, the advantage of motive power; yet, on the other hand, they did not require a sufficient bulk of battery to supply the whole of their current. If they once had their local centres—and they must have local centres, whatever system of distribution they had—it really did not matter in the least whether their apparatus was an apparatus revolving or whether it was an apparatus that was stationary.

The first question which we have to consider in comparing the systems is supposing that both are working over the same area, which is to be preferred by the public? My own impression is that the battery system would carry the day, even though one shilling per unit were charged instead of 7½d. In the first place they are afraid of the high tension system, and also are prejudiced in favour of the idea of pumping into a reservoir, from which you draw as required, and it appears to them, from a common sense point of view, that this is more reliable than depending on moving machinery. Battery systems must be divided into two distinct classes: those in which the battery is charged in the daytime and afterwards separated from the dynamo and discharged on to the lamps—in this case the depreciation will amount to 15 per cent. and the efficiency to 70; the second system is where dynamo and cells are run together during the heaviest part of the lighting, when the depreciation will be about 7 per cent and the efficiency 85 or 90 per cent. There seems to be a prevailing notion that the very presence of batteries in the installation involves the loss of 40 per cent of all the current used in the lamp. This is not the case; it is only the current which goes into the batteries and is reconverted back again that suffers any loss. If a charging current of 500 volts is employed there will be no danger to life, no loss in conversion of the current used by the lamps to the full extent of the dynamo output, there can be no sudden breakdown, the station can be worked with one shift of men, and the engine constantly kept going at the point of greatest economy. Under these circumstances, I cannot but think that batteries will compare very favourably with secondary generators. The main question is the depreciation of the batteries, and I quite agree with Mr. Sellon that the past is no criterion, for they have been placed in isolated installations in the hands of people who have no idea how to use them. Batteries properly looked after will last twice or three times as long as those which are not under supervision. There is another case to which I would refer, probably the oldest batteries in London, namely, those at the P. and O. offices, the plates for which were made even before we became connected with the Storage Company. These cells have lasted four years, and are now in perfect order; a result entirely due to the way in which Mr. Hall, the engineer, has looked after them. That batteries can be seen which have been worked in this way clearly shows that they can be relied upon under certain conditions; but for the present I do not agree with Mr. Crompton that in first cost and maintenance they can be made to compare with the secondary generator system. Where expense is the main object the district is spread, and large halls have to be lit more than private houses, the alternating system will undoubtedly be most used. But I do not attach much importance to the fact that in America the transformer system is the only one

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which has made any way, for the Americans have practically only one company who are devoting themselves to making secondary batteries, and they came over to England only a year or so back to learn how to make them. If the same amount of brain and time had been expended on batteries in America as on transformers we should no doubt have heard from Professor Forbes of the hundreds of tons of batteries he saw, as well as the large quantities of transformers. Automatic contrivances will, no doubt, be useful, but I see no reason why the system should not be started without them, provided the cells are put in central distributing depots, for the man in charge can easily switch the batteries in and out as required by hand. Finally, I am of opinion that both systems can be made to work quite satisfactorily and to pay their way, but I am convinced that the question as to which system is most largely adopted for the next few years in England will depend very much more upon the engineers than upon the system itself; whichever gets the best men in the early days will become fashionable, and more time will be devoted to its development. If the battery system only receives the same attention as the secondary generator system, and good practical engineers are interested in its development, I cannot but think that the battery system will hold its own both now and in the future.

Mr. FRANK KING said as the first man in England who had put into practice what Mr. Crompton had written about, he had listened to the Paper with great interest. He thought that Mr. Crompton might have gone a little further in discharging arrangements, so as to utilise a higher tension for that purpose. He used an E.M.F of 1,250 volts at Colchester; that was running $2\frac{1}{2}$ years, and they had had not the slightest difficulty with the cables or dynamo machines, although the material that the cells made of was giving way. There was every incentive for the insulation cables and the dynamos to break down, but they did not. When the cables were taken out they were nearly as perfect as when they were laid down. He should, perhaps, in almost every instance with a secondary battery prefer to use a potential up to 2,750 volts. He was quite sure the insulation of the battery could be made so perfect as to allow of that being safely used, and not only so far as the consumer was concerned, but safely as far as the attendants were concerned. In another installation that he laid down some four years ago, at Mr. Alfred Rothschild's mansion, they were charging a set of batteries with an E.M.F. of 535 volts through something like a mile of charging cable, and in that instance the cable, which was of a light nature, as that at Colchester, had never given the slightest trouble from insulation. He merely mentioned this to draw attention to the fact that Mr. Crompton might have gone considerably further with the potential for charging, and, consequently, saved a very large amount for charging the cables. The next point was that Mr. Crompton only used four distributing stations, and he (the speaker) was very confident that he would find that the E.M.F. would vary very considerably. He himself should use for the same purpose at least ten battery stations, or, if the area was a good one, something like Kensington, he might go as low as six. In what was known as the B. T. K. system they charged their batteries in two halves during the day, and as a matter of fact nine hours actually worked was sufficient for the whole three and a-half or four hours for which the consumption was required. With regard to the durability of storage batteries, they had inherent defects in themselves which had until lately been overlooked. But there was not the slightest reason why a battery should not be made in which it was absolutely impossible for any internal action to take place which would run that battery down, and he thought that it would be agreed that unless such action did take place there was no reason to doubt that the storage battery would remain in order. In fact, he had advised his own Company, wherever batteries were used in such manner as he himself had advocated, that they would be able to make 50 per cent. profit if they guaranteed to keep them in order at 12 per cent. There was one thing that he should like to say to all engineers proposing to use storage batteries, if they attempted to charge a number of storage batteries in parallel they would most certainly come to grief. Storage batteries must be charged in a series, so that every cell obtained an identical charge with its neighbours, and they must also be discharged in series, and the result would be that the battery would keep in order.

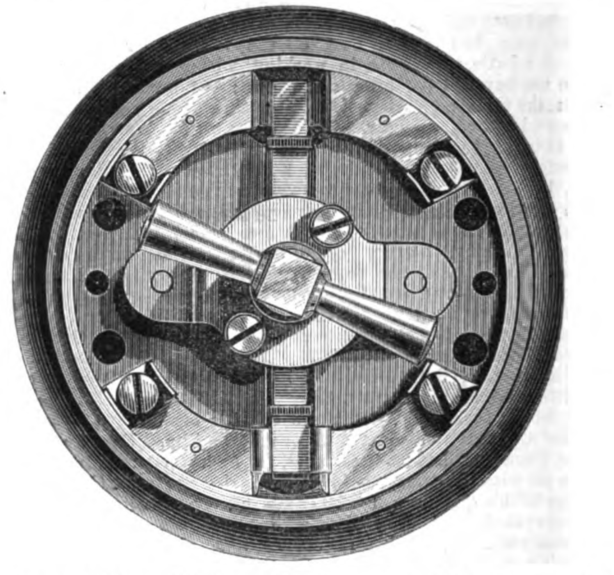
Mr. STEWART RUSSELL said that Mr. Crompton had really based a great deal of his argument in favour of the battery system on the great difficulties with which they would be met when they tried to use conductors for high-tension currents. He had looked up a few instances in which underground cables had been successfully used, and just as several of the speakers had pointed out with regard to batteries, they must not judge of what was going to be done by the earlier failures. Mr. Sellon had referred to the very disastrous experience which their Company had had in the matter of underground cables, but he would like to ask him how far back that was and of what class of cable, how it was laid and a few particulars about it, instead of being contented with a very general statement from that gentleman; and because, as far as he had been able to see in looking up this question, the failures which had occurred with underground wires had occurred really from a very poor class of cable compared with what they were putting down now. In early efforts cables were insulated with gutta percha, and practically with no mechanical protection at all; or they were insulated with pure rubber, or some resinous material, and drawn into tubes, with the result that the insulation was in many cases damaged. The result was only to be expected, and he believed the same result would have occurred in using such a moderate potential as 100 volts.

After a few words from Mr. FLEETWOOD

The CHAIRMAN announced that the discussion must close and that they would hear Mr. Crompton's reply on the 17th May.

Westinghouse Fittings exhibited by Professor Forbes.

Fig. 1 shows the working parts of a 10-ampere double-pole switch, constructed by the Westinghouse Company of America. It consists of a brass bar pivoted at the centre, the two ends being insulated from one another by two thin slabs of insulation. At either end of the bar are a pair of copper spring contacts about $\frac{1}{4}$in. apart, making contact respec-



tively above and below with the rocking bar. From this arrangement it follows that when the bar is tilted in one direction it passes between the copper springs at each end, and thus completes the circuit across each pair of contacts. When tilted in the reverse direction contact is broken at either end. The tilting of the bar is effected by turning the handle, bringing the spring into play, which presses a projecting stud, first on one side and then on the other side of the centre of the bar, as the handle moves over a double cam. The switch is mounted upon a base of vulcanised rubber.

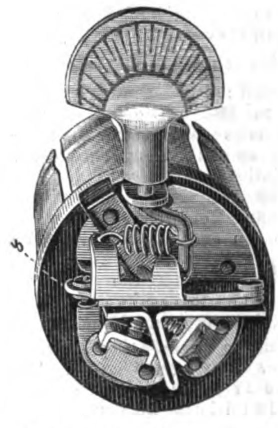


Fig. 2 shows a single lamp switch with the cover off. It has a rubbing double contact at *a*, with spring throw-off. The handle is of metal and is insulated from the contact pin by a washer of ebonite.

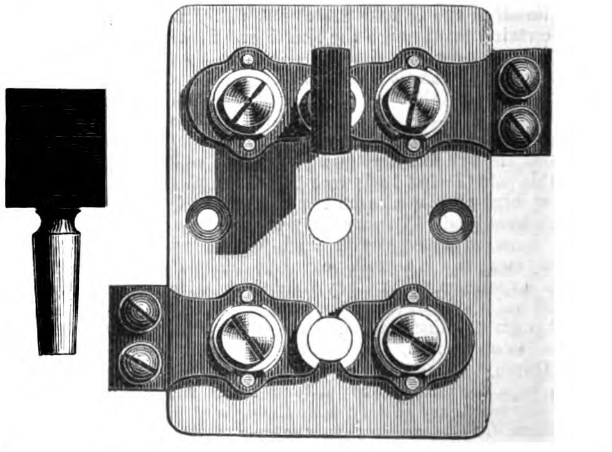


Fig. 3 represents a double-plug switch and fuse block, made of rough copper casting, mounted on a substantial slab of glazed earthenware. The wires are carried into the short tubes or loops at the side.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 690.)

105. *Permanent Magnet Controlling Field.*—A galvanometer is usually provided with a permanent magnet, by means of which its sensitiveness may be reduced to any desired extent. This is placed vertically above the needle, and can be shifted vertically so as to vary its effect upon the latter. If it is lowered closer to the needle its force on the latter is increased, and a stronger current through the coil of the instrument will be

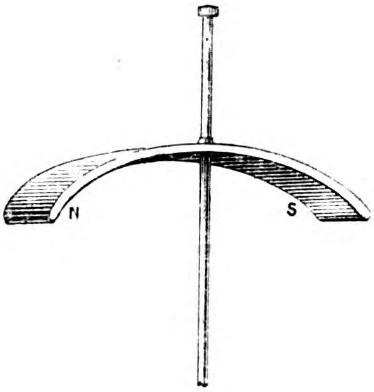


FIG. 65.

required to deflect the needle through a given angle—in other words, the sensitiveness of the galvanometer has been reduced. When the current is stopped, the needle is controlled or directed back to the plane of the coil by the directing action of the field of the permanent magnet. Hence, the magnet is known as a *controlling* or *directing magnet*, and the magnetic-field produced by it in the region of the needle's movement a *controlling* or *directing field*. This controlling magnet is generally placed in such a position that its magnetic-field is in the same direction as that of the earth's horizontal magnetic-field. This is not absolutely necessary in

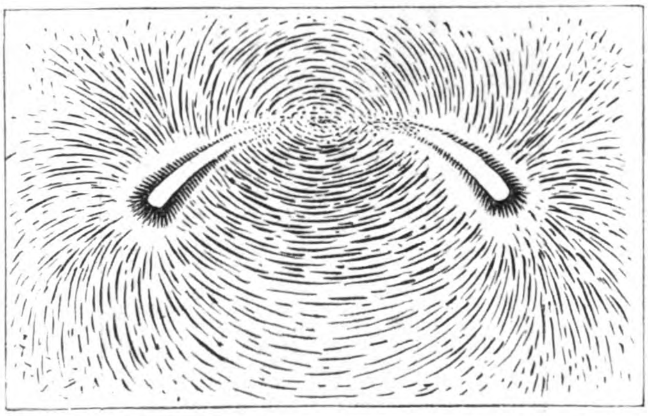


FIG. 66.

ordinary tangent galvanometers, as the tangent law holds good whether the controlling field is that of the earth or a controlling magnet, or both combined; that is, the instrument follows the tangent law equally as well when the controlling magnet keeps the needle parallel to the plane of the coil when no current is on, even though the plane of the coil is not in the magnetic meridian. When this is the case the actual controlling force on the needle is the resultant of that due to the earth and that due to the permanent magnet. In instruments, however, reading absolutely in terms of the controlling field, such as Sir William Thomson's graded potential and current galvanometers, it is absolutely necessary, if a controlling magnet is used, to place it so that its field is in the same direction as that of the earth. This is easily done by first levelling and moving the instrument till the needle is in the same plane as the coil (shown by the pointer being at zero) and then placing the magnet over the needle and varying its position till the pointer stands at zero again; the two fields must then be parallel. In Fig. 65 is shown the controlling magnet of a Thomson reflecting galvanometer. A split brass tube attached to the magnet causes it to grip the vertical guide rod, and remain in any position in which it is placed. The magnetic field surrounding this magnet may be understood by the iron-filing diagram in Fig. 66, which was taken with this magnet. The lines of force are in perfectly regular curves, and it can be seen that by giving the magnet its slightly curved shape the strongest part of the field is thrown downwards towards the needle. Now, in order that

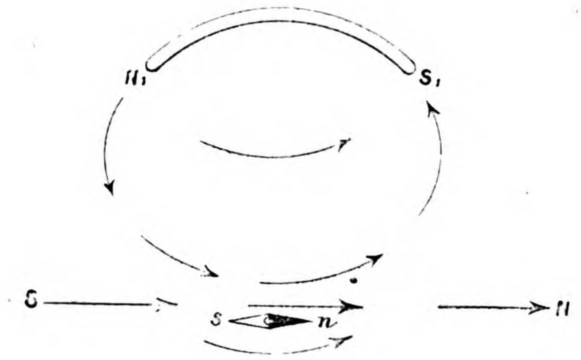


FIG. 67.

this magnetic field shall be in the same direction as that of the earth, the south pole of the magnet must point towards the north pole of the earth. For if the earth's field is represented by the straight arrows N S in Fig. 67, and the curved arrows represent the direction of field due to the magnet $N_1 S_1$, it is

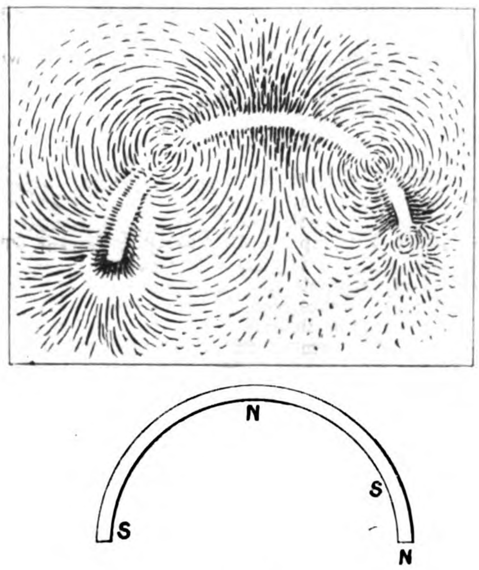


FIG. 68.

evident the two fields will agree in direction when the magnet is so placed—in other words, the lines of force of the two fields must be in the same direction for them to act together; and the *north* pole of a magnetic needle, *n s*, free to turn on its centre, always points *towards* the direction in which the lines of force are assumed to act (para. 104). This last fact is well to bear in mind.

An important point is that the controlling magnet should be magnetised regularly—that is, as in Figs. 65 and 66, where

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only two poles appear. If more than two poles exist in the magnet we get an irregular field, as shown in Fig. 68, which is taken from an actual magnet with two distinct additional poles. Such additional poles are known as "*consequent poles.*" The diagram of the field of this magnet, taken with iron filings, shows very well the three complete magnetic circuits of lines of force which exist in it. Such a state of affairs had probably been due to this magnet being placed near other magnets, or touching them at different points. To magnetise a controlling magnet regularly the best way is to wrap it round with a layer or two of insulated wire, and then pass a strong current through the wire, tapping the magnet with a mallet to reduce the friction between the molecules of the iron, and allow them to take a permanent set in the direction of magnetisation. A perfectly symmetrical magnetic field is exhibited in Fig. 69, where two semi-circular controlling magnets of an ordinary mirror signalling instrument are placed almost together, with opposite poles *vis-à-vis.* Each magnet completes its own magnetic circuit through the other—that is, instead of all the lines of force branching out from one pole and bending towards the opposite pole of the same magnet, as in the single magnet in Fig. 66, the greater part now branch towards the opposite pole of the other magnet and complete their circuit

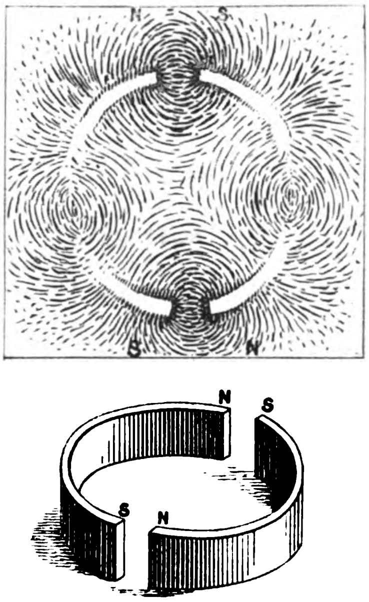

FIG. 69.

through its mass, this being an easier path for them than through the air.

(*To be continued.*)

THE MAXIMUM EFFICIENCY OF INCANDESCENT LAMPS.*

BY JOHN W. HOWELL.

The word efficiency, when applied to an incandescent lamp, is used to designate the amount of energy required by the lamp for the production of a given amount of light. Thus we say that a given lamp has an efficiency of 3 watts per candle, at 16 candles; meaning, that to produce an illumination of 16 candles we must supply the lamp with 48 watts.

The word efficiency, when applied to a prime mover or to any piece of apparatus that changes energy from one form to another, or which transmits or utilises energy, has a well-defined meaning, and is used to represent the ratio of the energy of the useful effect produced by the apparatus, to the energy necessarily supplied to the apparatus to enable it to produce that effect.

An incandescent lamp transforms electrical energy into heat and light, so the use of the word efficiency to denote the watts per candle required by the lamp is not a proper one. To denote properly the efficiency of an incandescent lamp we must be able to separate the energy of the light produced by it from the energy of the heat produced. Then the ratio of the energy of the light to the electrical energy required by the lamp will be a correct expression for the efficiency of the lamp, and we will have to find some other word to designate the watts per candle. In this Paper the word efficiency is used in its ordinary improper sense to denote the watts per candle required by a lamp when producing a given amount of light.

The efficiency of a lamp varies with its candle-power. The curve (Fig. 1) shows the rate of this variation for a particular lamp. At 5 candles this lamp has an efficiency of 6·7 watts per candle; at 10 candles it is 4·2 watts per candle, and at 20 candles it is 2·66 watts per candle.

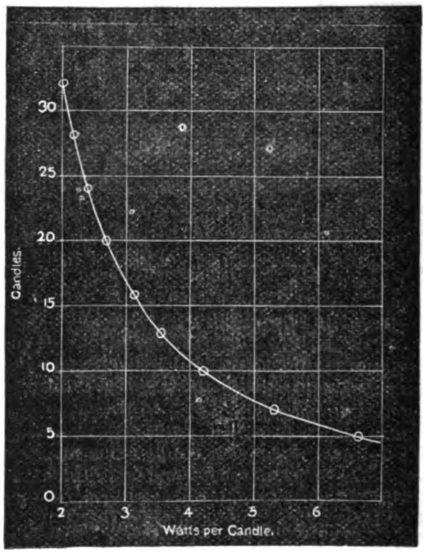

FIG. 1.

Any statement regarding the efficiency of a lamp must therefore be accompanied by a statement of the candle-power at which it has the stated efficiency; without this it is meaningless. There is nothing in an incandescent lamp itself that fixes its proper efficiency or in any way indicates what it is. The lamp from which the curve (Fig. 1) was determined has, within the limits of the curve, any efficiency between 2 and 7 watts per candle. Thus, by simply changing the candle-power of the lamp we can operate it at any efficiency we choose, and get as much or as little light per watt as we choose.

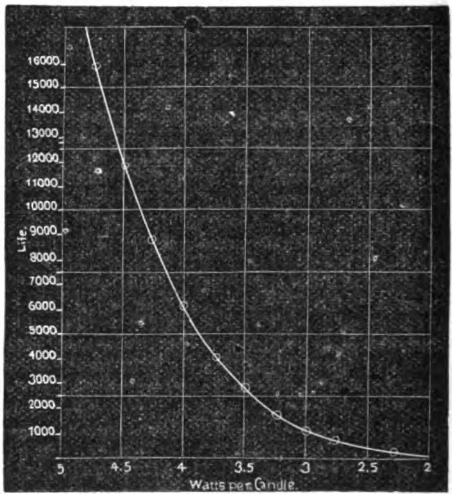

FIG. 2.

In commercial practice the candle-power of lamps is always marked on them, and their efficiency at this candle-power is stated; but even this is not a proper index to the value of the lamp or to its proper efficiency. Experience has shown that lamps are almost universally run above their normal rating; lamps rated at 4·5 watts per candle are usually run at from 3·5 to 4 watts per candle, and in order to make lamps that will stand the strain of being run above their rated capacity, it is necessary to rate them considerably below the efficiency at which they will give the best results under ordinary circumstances.

* A Paper read before the American Institute of Electrical Engineers April 10, 1888.

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Lamps have been made and sold in England which have a very high rated efficiency; but parties buying these lamps are told that they will get very much more satisfactory results if they run the lamp *below their rated capacity*. So we see that some lamps are rated above their capacity and some are rated below, and the rated efficiency of a lamp is not always the best efficiency at which to run it. How, then, are we to determine the efficiency at which a lamp will give the best results? It is this question which I will attempt to answer.

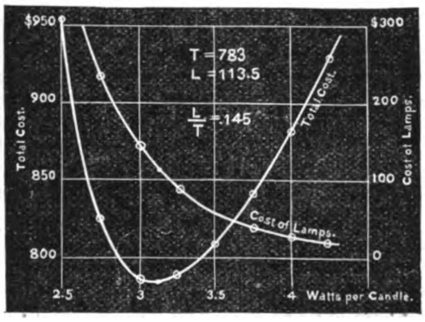
The term "maximum efficiency" of a lamp, as used in the title of this Paper, does not mean the highest efficiency at which a lamp can be operated, but the efficiency at which the best results are produced by the lamp, or, more accurately, *the efficiency at which the cost of operating the lamp is a minimum.*

Taken in this latter sense, the maximum efficiency of a lamp is not its highest efficiency. As we increase the candle-power of a lamp its efficiency increases; consequently, by running the lamp high enough we can make its efficiency so high that very little power is required to produce a given amount of light, and the cost of the power to produce the light is very small. But, while the efficiency of the lamp increases, its life decreases, and if we run a lamp at too high an efficiency the saving in the cost of power is more than balanced by the increased cost of lamp renewals.

To determine the maximum efficiency for lamps under given conditions, we must determine the efficiency at which the sum of the costs of power and lamps is a minimum, and in order to do this we must know the rate of variation of the life of a lamp with its efficiency.

The curve, Fig. 2, shows this rate of variation. This curve is the result of very carefully conducted experiments made by the Edison Company. These experiments extended over five years and consumed a very large number of lamps. Its accuracy when applied to Edison lamps is beyond question; but our experiments with lamps having an artificial surface on the carbon, or "flashed" lamps as they are called, show that their rate of variation of life and efficiency follows a different curve.

Lamps 85c. each—Life 600 hours at 3 Watts per Candle.
Current costs 10c. per H.-P. per hour.



Minimum at 3·1 Watts per Candle. ∴ Maximum Efficiency 3·1 Watts per Candle.

Fig. 3.

This curve does not apply to individual lamps. If we take two Edison lamps and burn them at different efficiencies, their lives for these efficiencies will probably not be such as indicated by the curve, nor will they be proportioned to these indicated lives. But if we take one hundred lamps and burn them at one efficiency, and another hundred equally good lamps and burn them at another efficiency, the average lives of the two sets will be proportional to the lives indicated by the curve for these two efficiencies.

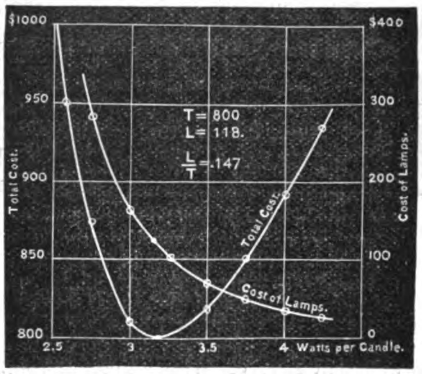
In order to determine at what efficiency the cost of operating lamps of a given quality under given conditions is a minimum we must calculate what this cost is at different efficiencies. To do this we consider the total cost of operating the lamps to be made up of two parts, viz., the cost of the *current* and the cost of the *lamps.* The cost of the current is made up of every expense incurred in operating the lamps, including materials consumed, labour, taxes, insurance, rent, and every other expense incurred in operating the plant, except the cost of lamps. The cost of the lamps is an item by itself, and is the amount which the lamp has cost when it is put in use. This is a natural division of the total cost of operating a plant, since to produce light by incandescence all that is necessary is a lamp and current to operate it.

If, in any case, we know the cost of the current required to operate the lamps, the cost of the lamps, the quality of the lamps—that is, the life they will give when burned at a given efficiency—and the rate of variation of their life with efficiency, we can then calculate at what efficiency the cost of operating the lamps is a minimun, and this I call the maximum efficiency of those lamps.

The following examples show what this maximum efficiency is under varying conditions of the cost of lamps, the cost of current, and the quality of the lamps. The cost of the lamps I have varied between 25 cents and 1.00dol. each. The cost of current varies between 2.5 cents and 10 cents per horse-power per hour. The quality of the lamps varies between 300 hours life at 3 watts per candle and 2,400 hours life at 3 watts per candle.

In each of the following cases I have calculated the cost of operating 100 16 candle-power lamps 1,000 hours, at each of the efficiencies comprised in the curve of total cost. These curves do not show the cost of running the same lamps at different efficiencies, but the cost of running equally good 16-candle lamps of the different efficiencies.

Lamps $1.00 each—Life 600 hours at 3 Watts per Candle
Current costs 10c. per H.-P. per hour.



Minimum at 3·18 Watts per Candle.
∴ Maximum Efficiency 3·18 Watts per Candle.

Fig. 4.

The first case we will consider is shown in the diagram Fig. 3. In this case the lamps are assumed to cost 85 cents each, and to have a life of 600 hours at 3 watts per candle. The current is assumed to cost 10 cents per horse-power hour.

The cost of the current is determined from the following formula:—

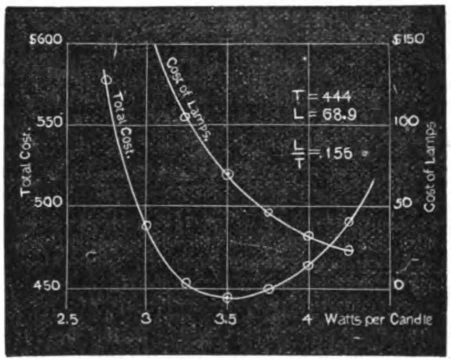
Current cost

$$= \frac{\text{w. p. c.} \times 16 \times 100 \times 1{,}000 \times \text{cost of ct. per h.-p. per hour}}{746}.$$

And the cost of lamps from this formula:—

$$\text{Cost of lamps} = \frac{\text{cost of one lamp} \times 100 \times 1{,}000}{\text{life at given efficiency}}.$$

Lamps $1.00 each—Life 600 hours at 3 Watts per Candle.
Current costs 5c. per H.-P. per hour.



Minimum at 3·5 Watts per Candle.
∴ Maximum Efficiency 3·5 Watts per Candle.

Fig. 5.

The curve marked *total cost* shows the total cost of running 100 16 candle-power lamps 1,000 hours, the efficiencies of the lamps varying between 2·5 and 4·25 watts per candle. The efficiencies are shown by the vertical lines, referring to the scale at bottom. The value of the total cost at any point of the curve is shown by the horizontal line through the point, referring to the scale at the left of the diagram.

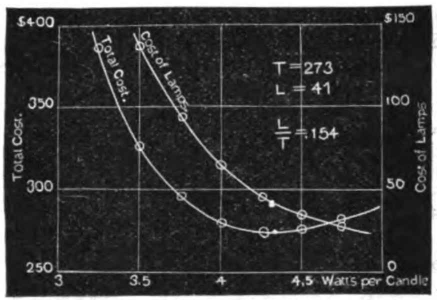
The lowest point of the curve shows the point where the total cost is lowest. This is the minimum cost of operating these lamps under the given conditions. The mark at the lowest point of the curve shows this minimum cost to be 783dols., and a vertical line through this point to the scale at bottom of the diagram shows

that this total cost is a minimum when lamps having an efficiency of 3·1 watts per candle are used.

Thus the maximum efficiency of these lamps under the conditions assumed is 3·1 watts per candle.

The lamps considered in the case shown in Fig. 4 cost 1.00dol.; all other conditions are the same as in the case shown in Fig. 3. This increases the total cost from 783dols. to 800dols., and necessitates using lamps of 3·18 watts per candle instead of 3·1, to make the cost of operating a minimum.

Lamps $1.00 each—Life 300 hours at 3 Watts per Candle.
Current costs 2.5c. per H.-P. per hour.

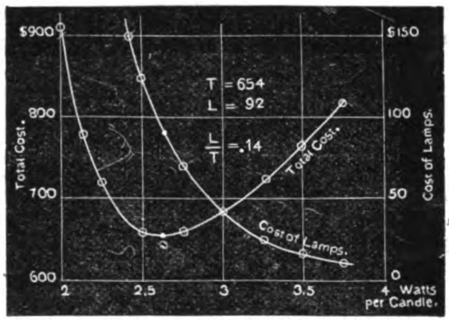


Minimum at 4·32 Watts per Candle.
∴ Maximum Efficiency 4·32 Watts per Candle.

FIG. 6.

In the case shown in the diagram, Fig. 5, the current costs 5 cents per horse-power hour; the other conditions are the same as in the case assumed in Fig. 4. The minimum total cost in this case is 444dols., and to make this cost a minimum we must use lamps having an efficiency of 3·5 watts per candle.

Lamps 50c. each—Life 1,200 hours at 3 Watts per Candle.
Current costs 10c. per H.-P. per hour.

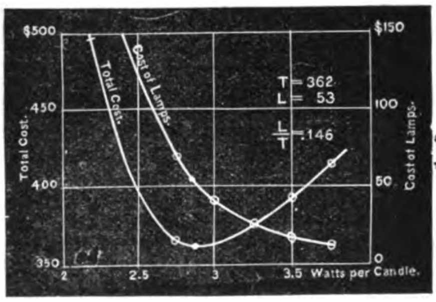


Minimum at 2·62 Watts per Candle.
∴ Maximum Efficiency 2·32 Watts per Candle.

FIG. 7.

In the case shown in Fig. 6 the lamps cost the same as in the last, but are only half as good; the current costs just half as much as in the last case. The minimum total cost in this case is 273dols., and the maximum efficiency of the lamps is 4·32 watts per candle.

Lamps 50c. each—Life 1,200 hours at 3 Watts per Candle.
Current costs 5c. per H.-P. per hour.

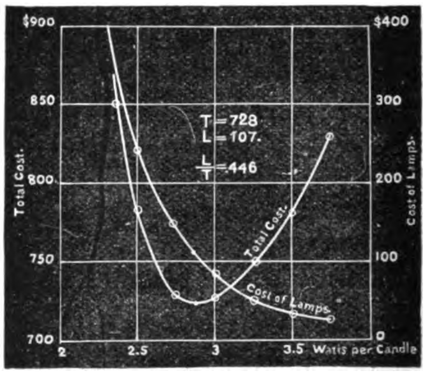


Minimum at 2,875 Watts per Candle.
∴ Maximum Efficiency 2·88 Watts per Candle.

FIG. 8.

In the case shown in Fig. 7 the lamps cost 50 cents, and have a life of 1,200 hours at 3 watts per candle. The current costs 10 cents per horse-power per hour. This is the cheapest and also the best lamp we have yet considered, but the current is expensive. In this case the minimum total cost is 654dols., and the maximum efficiency of the lamps is 2·62 watts per candle. In this case, Fig. 8, the current costs half as much as in the previous case, other conditions being the same. The minimum total cost is reduced from 654dols. to 362dols. The maximum efficiency in this case is 2·88

Lamps 50c. each—Life 600 hours at 3 Watts per Candle.
Current costs 10c. per H.-P. per hour.



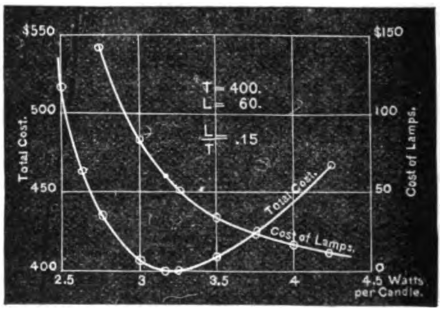
Minimum at 2·88 Watts per Candle.
∴ Maximum Efficiency 2·88 Watts per Candle.

FIG. 9.

watts per candle. In Fig. 9 the current costs twice as much as in the previous case, and the lamps are only half as good. The minimum total cost is doubled, but the maximum efficiency is the same as in the previous case.

In this case (Fig. 10) the current costs one-half of that assumed in the previous case, other conditions being the same. The minimum total cost is 400dols., and the maximum efficiency 3,175 watts per candle.

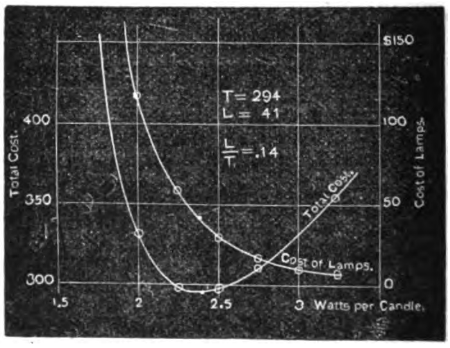
Lamps 50c. each—Life 600 hours at 3 Watts per Candle.
Current costs 5c. per H.-P. per hour.



Minimum at 3·175 Watts per Candle.
∴ Maximum Efficiency 3 175 Watts per Candle.

FIG. 10.

Lamps 25c. each—Life 2,400 hours at 3 Watts per Candle.
Current costs 5c. per H.-P per hour.



Minimum at 2·38 Watts per Candle.
∴ Maximum Efficiency 2·38 Watts per Candle.

FIG. 11.

The curve (Fig. 11) illustrates the case of very cheap and very good lamps, with moderate cost of current. The minimum total cost is low, 294dols., while the lamps are run at the high efficiency of 2·38 watts per candle.

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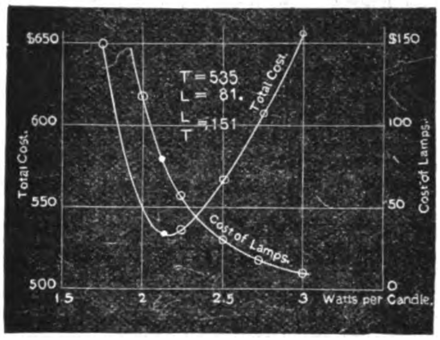
In the case shown in Fig. 12, the cost and quality of the lamps are the same as in the previous case, but the current costs twice as much. This increases the minimum total cost from 294dols. to 535dols., and raises the maximum efficiency to 2·14 watts per candle.

In the case (Fig. 13) the cost of lamps and the cost of current are the same as in the case shown in Fig. 11, but the lamps are only half as good. The minimum total cost is increased from 294dols. to 327dols., and the maximum efficiency is reduced from 2·38dols. to 2·62 watts per candle.

The first and plainest inference drawn from these curves is that the maximum efficiency of any given lamp is not a fixed one, but varies with conditions outside the lamp itself. Identical lamps operated under different conditions of cost of current must be

Lamps 25c. each—Life 2,400 hours at 3 Watts per Candle.
Current costs 10c. per H.-P. per hour.



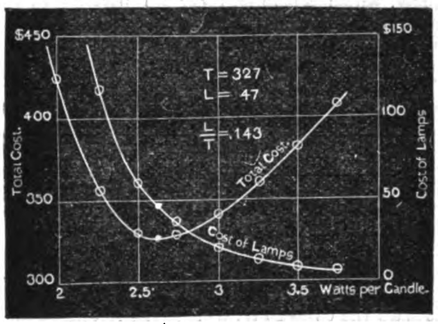
Minimum at 2·14 Watts per Candle.
∴ Maximum Efficiency 2·14 Watts per Candle.

FIG. 12.

burned at different efficiencies to make the cost of operation a minimum for the production of a given amount of light. In order to determine the maximum efficiency of lamps, therefore, we must know the quality of the lamps referred to some standard, the cost of the lamps to the consumer, and the cost of current under the actual conditions existing at the place where the lamps are to be used.

In the eleven cases shown in this Paper the lamp of highest efficiency is obtained in the case shown in Fig. 12. This is a case where the lamps are very cheap and very good, and current is very expensive. The lamp having the lowest efficiency is obtained in the case shown in Fig. 6, in which the lamps are poor and high-priced and the current is very cheap.

Lamps 25c. each—Life 1,200 hours at 3 Watts per Candle.
Current costs 5c. per H.-P. per hour.



Minimum at 2·62 Watts per Candle.
∴ Maximum Efficiency 2·62 Watts per Candle.

FIG. 13.

There is a marked difference in the sharpness of these curves at the minimum points. An inspection will show that the sharpness of the bend in these curves depends upon the cost of the current, the curves in which the current costs 10 cents per horse-power per hour being the sharpest. Those in which the current costs 5 cents are next, and the one (Fig. 6) in which the current costs only 2½ cents per horse-power per hour is very flat at the bottom or minimum point. In this comparison Fig. 7 is not considered, as it is drawn on a different scale from the others, and is not as sharp as it should be.

This indicates that the more expensive the power is the more carefully must the lamp efficiencies be chosen. In Fig. 12, which shows the sharpest curve, a very slight variation in the efficiencies of the lamps makes a very great change in the total cost of operation.

In the case shown in Fig. 6, in which the current is very cheap, we find that a very considerable change in the efficiency of the lamps used makes very little difference in the total cost or operation.

On each of the eleven diagrams two curves are drawn, one showing the total cost of the operation and the other showing the cost of lamps. On each of the curves showing the cost of lamps a point is marked which indicates the cost of the lamps when the total cost is a minimum. The letter T marked on each of the figures denotes the minimum total cost of operating the lamps under the given conditions. The letter L denotes the cost of the lamps when the total cost is a minimum, and the expression $\frac{L}{T}$ denotes the ratio of the cost of lamps when the total cost is a minimum, to the minimum total cost. An examination of all these curves shows that while the minimum total cost varies with each of the three quantities—price of lamps, quality of lamps, and cost of current—nevertheless, *the total cost is always a minimum when the cost of lamps is about 14·5 or 15 per cent. of the total cost of operation.*

This figure varies somewhat in the different examples considered, but the variation seems to follow no law. In Figs. 6 and 12, which show the highest and lowest efficiency lamps, the figures are 15·1 per cent. and 15·4 per cent. respectively.

The steepness of the curve showing the cost of lamps, and the difficulty of determining the exact minimum point of a curve which has been drawn by inaccurate methods, makes it difficult to get the cost of lamps accurately when total cost is a minimum. These curves and values are given just as they were determined, and no effort has been made to bring the results into closer agreement, as could readily have been done. I consider the variation shown by these curves to indicate closely enough that this ratio of cost of lamps to total cost at the minimum point is nearly, if not quite, constant, and that its value is between ·145 and ·15.

This establishes a very simple law for determining whether or not lamps are being operated at their maximum efficiency; for if they are, the lamp bills will be about 15 per cent. of the total operating expenses of the plant. If the lamp bills are more than 15 per cent. of the total operating expenses the lamps are being burned above their maximum efficiency, and lower efficiency lamps should be obtained. If, on the other hand, the lamp bills are less than 15 per cent. of the total expenses of the plant the lamps are being burned below their maximum efficiency and higher efficiency lamps would reduce the cost of operating the plant. Where fuel is high-priced, or where other causes operate to make the cost of generating current high, it is specially important to use lamps of the maximum efficiency, for we have seen from the above curves that where the cost of current is high the use of lamps whose efficiency is a little above or below the maximum efficiency attainable under the conditions of operation makes a very marked increase in the operating expenses of the plant.

If in any plant the lamp bills are only 10 per cent. of the total expenses, then *increasing the efficiency of the lamps by increasing their candle-power does not diminish the total cost of operating the plant.* In order to reduce the total cost *the lamps must be replaced by lamps of the same candle-power but of higher efficiency.* If the efficiency of the lamps is increased by raising their candle-power, the cost of operating the plant *per unit of light produced* is reduced, but the total cost is increased. A plant which is paying less than 15 per cent. of its total expenses for lamps, and which brings the lamp bills up to 15 per cent. by increasing the candle-power of the lamps does not decrease the cost per lamp of operating the plant, but *does* decrease the cost per candle of light furnished. If they are paid for the increased light given by the lamps the efficiency of the plant is made a maximum for the existing conditions; but if they are not paid for the additional light furnished the efficiency of the plant is reduced.

This law enables any one operating an incandescent lamp plant to determine whether or not he is using the most suitable lamps for his plant. If the conditions of operation of a new plant are all known, and the quality of the lamps made by any lamp maker is known, we can determine before starting what is the most economical lamp to use.

JUDGMENT OF THE SUPREME COURT OF THE UNITED STATES IN THE TELEPHONE APPEALS.

(Concluded from page 668.)

DRAWBAUGH FAILS TO REPRODUCE HIS ALLEGED RESULTS.

But there is another fact in this case equally striking. As has already been seen, F, D, C, and I were in no condition for use when they were produced and put in evidence. They were mere remains. No one but Drawbaugh himself could state how they were made or how they were to be used. He undertook to reproduce some of them, especially F and G. This was in the latter part of 1881, while the testimony was being taken. The Bell Company proposed that they should be tried, to see if they would do what the witnesses said had been done with the originals, which the remains show must have been exceedingly primitive in their character;

The testimony also shows that when they were originally used, by or in the presence of the witnesses, no particular care was taken in their adjustment. They were lying around in the shop or placed upon shelves. Some say that when the experiments were made they were held in the hands or allowed to stand on a table. In order to reach satisfactory results Drawbaugh himself said in his deposition :—

"I had persons in the cellar reading printed matter, some advertisement or something, and I could hear the words that were read ; and at other times I would go down into the cellar and read something and come up, and they would repeat the words to me that I had read."

The proposition of the Bell Company was accepted, and the reproductions were tried in March, 1882, under the most favourable circumstances. It is substantially conceded that the trial was a failure. Occasionally a sound was heard and sometimes a word, but it would not transmit sentences. At the time of these experiments F, which was the transmitter, was placed on a table as Drawbaugh said it was originally.

Two years afterwards other reproductions were presented, differently constructed and used in a different way. Those would talk, but they were neither the same nor used in the same way as the originals. To our minds, the result of the experiment conclusively shows that the original instrument could not have been of a construction similar to the reproductions, and that what they had done was produced by some other means.

We do not doubt that Drawbaugh may have conceived the idea that speech could be transmitted to a distance by means of electricity, and have experimented upon that subject. But to hold that he discovered the art of doing it before Bell did would be to construe testimony without regard to the ordinary laws that govern human conduct. Without pursuing the subject further we decide that the Drawbaugh defence has not been made out.

THE ALLEGED FRAUD IN THE PATENT OFFICE.

Another objection to Bell's patents put forth in the oral argument of Mr. Hill, and in the printed brief signed by him, and in that signed by Mr. Dixon, is that the application as originally filed in the Patent Office did not contain his present fourth claim, or any description of the variable-resistance method, and that all which now appears in the specification on that subject, including the fourth claim, was surreptitiously interpolated afterwards. Bell's application was filed February 14th, 1876, and afterwards, during the same day, Elisha Gray filed a caveat in which he claimed as his invention "the art of the transmission of vocal or other sounds or conversation telegraphically, through an electric circuit," and in his specification described the variable-resistance method. The precise charge now made in the printed brief of Mr. Hill is :—

"That Mr. Bell's attorneys had an underground railroad in operation between their office and Examiner Wilber's room in the Patent Office, by which they were enabled to have unlawful and guilty knowledge of Gray's papers, as soon as they were filed in the Patent Office ; and that an important invention and a claim therefor were bodily interpolated into Bell's specification between February 14th, 1876, and February 19th, 1876, by Pollok, in consequence of the guilty knowledge which the latter already had of the contents of Gray's caveat before the declaration of interference with Gray on February 19th."

So grave a charge, made in so formal a manner, is entitled to consideration. It involves the professional integrity and moral character of eminent attorneys, and requires us to find from the evidence that after Bell swore to his application on the 20th of January, 1876, and after the application thus sworn to had been formally filed in the Patent Office, an examiner, who got knowledge of the Gray caveat put in afterwards, disclosed its contents to Bell's attorneys, and they were then allowed to withdraw the application, change it so as to include Gray's variable-resistance method, over Bell's signature and over the jurat, and then to restore it to the files thus materially altered, as if it were the original, and all this between February 14th and February 19th. Although much stress was laid in the argument on the fact that what purported to be a certified copy of the specification of Bell, as found in the file-wrapper and contents printed in the Dowd case, differed materially from the patent, the occasion of these differences has been explained in the most satisfactory manner.

We entertain no doubt whatever that the specification, as now found in the patent, is precisely the same as that on which the order to issue was made. If any alterations were made they were all done before February 19th, and the fair copy which is now found on the files of the office is precisely as it was when the order for the patent was granted ; not a shadow of suspicion can rest on any one.

All that remains, therefore, on which to rest this serious charge is that in a paper handed by Bell to George Brown, of Toronto, describing his invention, and which was intended to be used in England to secure a British patent, there is now claimed to be an interpolation which in the American application is not to be found. It is but right to say that during the whole course of the protracted litigation about the Bell patent no argument was ever presented based on this discrepancy until the brief of Mr. Hill was filed in this court on Jan. 18, 1887, six days before the argument on these appeals was begun. So far as we are advised, nothing has ever before occurred in the cases that seemed to make it necessary to prove when the variable-resistance method, or the fourth claim, was put into the American application, or why it was left out of the paper handed to Brown. It seems always to have been assumed, until the cases got here, that because it was in the American patent it was rightfully there. Certainly there is nothing in the pleadings in any of the cases to direct attention to the materiality of this fact. A comparision of the paper handed to Brown with the American application shows that they differ in more than thirty different places, besides those which relate to the variable-resistance method and the fourth claim. The differences are generally in forms of expression, this indicating that one was written after the other, and evidently for the purpose of securing greater accuracy. The paper handed Brown was merely a rough draft and not a fair copy, for the record shows that it bears on its face the evidence of numerous erasures and interlineations. Bell says in his testimony that he began writing this specification in October, 1875, and wrote and rewrote it a number of times, and fially adopted that mode of expression which seemed to him best to explain the invention and the relation which one portion bore to another. He visited Brown in Canada in September, and again in December, 1875. An arrangement was made between them on the 29th of December, at the last interview, by which Brown was to interest himself in getting out the British patent. Other inventions besides the telephone were included in the contract entered into for that purpose. Bell returned to Boston on the 1st of January, and immediately set himself to work to complete his specification. It was taken to Washington by Mr. Hubbard, about the 10th of that month, and delivered to Pollok and Bailey, his attorneys. It was then examined by his attorneys and found correct, and a fair copy made, and then returned on the 18th to Bell, for his signature. It was signed and sworn to in Suffolk County, on January 20th, and immediately returned to the attorneys. Afterwards Mr. Pollok met Bell in New York, and it was again gone over with care by the two together. No change whatever was made in it at that time, and Mr. Pollok took it back with him to Washington.

On the 25th of January, 1876, Bell met Brown, who was then on his way to England, in New York. It is now assumed that the papers which Brown took to England were handed to him then ; and because the variable-resistance method in the fourth claim was not in it, it is argued that it could not have been in the American specification at that time. But no one has said when the paper was actually handed to Brown. Bell says he cannot tell, but it must have been after he made his contract with Brown on the 29th of December. As the American specification was signed and sworn to five days before the interview with Brown on the 25th of January, and the paper of Brown differs from it in so many particulars besides that now in question, it would seem to be clear that the paper was a copy of some former draft that Bell had made and possibly taken to Canada in December, not that which was perfected afterwards. As the specification which had been prepared and sworn to was a fair copy, without erasure or interlineation, the fact that the paper handed to Brown was not a fair copy would imply that it was not intended to be an exact transcript of the other.

At any rate, the bare fact that the differences exist under such circumstances is not sufficient to brand Bell and his attorneys and the officers of the Patent Office with that infamy which the charges made against them involve. We therefore have no hesitation in rejecting the argument. The variable-resistance method is introduced only as showing another mode of creating electrical undulations, and that Bell had his mind upon such a method is conclusively established by a letter which he addressed to Mr. Hubbard on the 4th of May, 1875, and which is in the Dowd record, introduced into the Overland record by stipulation. Its insertion in his final draft of his specification is another proof of the care with which the work had been done.

INCORPORATION OF THE BELL COMPANY.

In the case of the Clay Commercial Company objection was made to the sufficiency of the proof of the incorporation of the American Bell Telephone Company. The first point is as to the act incorporating the American Bell Company, which authorised certain persons therein named to form a corporation; and second the certificate of the Secretary of the Commonwealth, in the form required by Section 111, Chapter 224, that certain persons, among whom were the members of this company, under the name of the American Bell Telephone Company were legally organised. This section made such a certificate conclusive evidence of the existence of a corporation organised under that Act. The authority granted by the special Act to the persons named to organise as a corporation in this way, gave them the authority to select a corporate name, and also made the statutory certificate conclusive evidence. The objections to the proof of title are not, in our opinion, well taken. We do not think it necessary to add to the length of this opinion by referring to the testimony upon that point.

THE SECOND BELL PATENT.

This disposes of all the cases so far as the patent of March 7th, 1876, is concerned. It remains now to consider only the other patent. It received but little attention by counsel or Court in either of the cases below. In the Dolbear case it was by consent excluded from the decree.

In the case of the Clay Commercial Company it was alleged in the answer that substantial and material parts of the things described and claimed were described and claimed in a prior British patent taken out December 9th, 1876, and inasmuch as the foreign patent does not bear the same date, if the American patent is not limited it is void. This point has not been pressed in the argument. In our opinion it has been settled by the decisions of this Court in *O'Reilly* v. *Morse* and in *Siemens* v. *Sellers* at the present term, that the effect is not to render it invalid if it is for the same invention, but only to limit its term. The patent in itself is for the mechanical structure of an electric telephone, to be used with the electrical action on which the first patent rests. The *third* claim is for the use, in such instrument, of a diaphagm made of a plate of iron or steel, or other material capable of inductive action ; the *fifth* is for a permanent magnet ; the *sixth* for a sounding box ; the *seventh* for a speaking or hearing tube, and the *eighth* for a permanent magnet and plate combined. The claim is not for these several things, but for an electrical telephone, in the construction of which those things or any of them are used. Hence the fifth claim is not anticipated, as was decided in the Molecular case below. The patent is not for a magnet, but for a telephone of which it forms a part To that extent the decree in that case was erroneous.

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THE DECREE.

It follows that the decree in each of the cases so, far as it is in favour of the Bell Company and those claiming under it, must be affirmed, and that the decree in the Molecular case, so far as it is against that company on the fifth claim of the patent, must be reversed, and a decree directed to that extent in its favour. It is accordingly so ordered.

Mr. Justice Gray was not present at the argument, and took no part in the decision of these cases.

JUSTICES BRADLEY, FIELD AND HARLAN DISSENT.

At the conclusion of the reading of the opinion of the Court, Mr. Justice Bradley made the following remarks:—

Mr. Justice BRADLEY: Mr. Justice Field, Mr. Justice Harlan and myself are not able to concur with the other members of the Court in the result which has been reached. The point on which we dissent is the question of Drawbaugh's invention. We think that Drawbaugh did anticipate the invention of Mr. Bell. We think that the evidence to that point is so overwhelming, both with regard to the number and character of the witnesses, that it cannot be overcome. Of course, it is a question of fact depending upon the weight of the evidence, and involves no question of law, and, therefore, it is a matter that does not require much observation on the part of those who dissent from the opinion, which is very ably drawn, and undoubtedly presents the whole case with great force. But on this point we cannot concur in the views of the Court. We think that Drawbaugh did have an instrument in his shop as early as 1869 which used the variable-resistance instrumentality in transmitting articulate speech to a distance, by means of electricity, and was distinctly heard and understood. That is the whole invention, so far as variable resistance is concerned.

We also think that as early as 1871 he did produce an instrument employing the magneto-electric instrumentality altogether, substantially the same as that which is claimed in Mr. Bell's patent. In the one case, with regard to the variable-resistance principle, over seventy witnesses were produced. The evidence of some of them may have been shaken with regard to the time that they had in mind; but the evidence of the great majority of them is not shaken at all. They were mostly plain people of the country, but they heard the words, and that is a matter that they could not be mistaken about. It did not require science nor literature nor refinement to understand that.

In regard to the other instrument, some 40 or 50 witnesses were produced who saw it. Many of them heard the language produced through it, and a number of witnesses who did not hear the language produced through these instruments, saw them or heard them talked about, so as to fix the time that they were in existence, and it seems to us that on this subject of time and of result there is such a cloud of witnesses that it is impossible not to give credence to them. There is no doubt that Mr. Bell's merits are very great in appreciating the importance of the discovery, and in bringing it before the public in such a manner as to make it appear to be what it is, one of the most important discoveries of the century. He was a man whose professional experience and whose scientific attainments enabled him to see at a glance the importance of it. Drawbaugh was a different sort of man. He did not see it. Had he done so, he would have taken measures to interest persons with him in it, and have brought it out. He was a mechanic, a plain mechanic, somewhat better instructed, perhaps, than most ordinary mechanics, a man of more reading, a man of more intelligence. But he looked upon what he made more as a curiosity than a matter of speculation, a matter of financial importance or of importance to the public. That is the way we view his condition of mind in regard to it, and explain why he had not taken more pains to bring it forward to the notice of the public. It is the tendency of the human mind to attach importance to the results and inventions of those who have achieved eminence. Watt was the idol of the British nation, from the time of his first invention of the steam engine until the day of his death, and until the present time; and everything that was invented about the steam engine was attributed to him. It was the glory of England, the glory of Watt, and of course every patriotic British subject would hoot at anything it was claimed Watt did not invent, or attribute it to him. That is a principle of the human mind on which we think a great deal may be explained with regard to the feeling towards this important service which Mr. Bell has rendered with regard to this invention. The plain mechanic of Pennsylvania is of no account. The scientific and illustrious—for he is illustrious—Mr. Bell, it cannot be but that he did invent this thing! And yet if Mr. Bell on the 14th day of January (I think it was) or February, when he applied for his patent at the Patent Office, had had in his laboratory the things that Drawbaugh had, he would have been filled with an excitement far exceeding that which has animated the great inventors of the world when they made the discoveries they have made, and he would have exclaimed, "Eureka! Eureka!" He would have appreciated it if Drawbaugh did not.

What had he when he applied for his patent? On the 10th of June, 1875, they thought they heard something, but were not sure; but he knew the principle, and he patented it. Up to the time of making his application for a patent they had not succeeded in producing intelligible speech, more than a word or two; perhaps a word or two. If Bell had done at that time as much as Drawbaugh had done according to the evidence, he would have had no hesitation in claiming the greatest discovery that the world has seen in the present century.

This is an outline of the views which we have on this subject. We have nothing to say depreciatory of Mr. Bell at all, for he has real merits; but we think that this obscure mechanic did do the thing, and that he is entitled to the merit of being the first inventor.

We will take an opportunity within a few days to write a further statement and file it.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April 21st*, 1888.

I mentioned in a recent letter the fact that Boston was very much interested at the present time in an attempt to secure exclusive franchises for electrical subways. Last week that franchise was granted, the parties accepting the franchise agreeing to pay to the city all the excess of their profits over 10 per cent. on the capital actually invested. At the end of ten years, too, it is provided that the city may buy out the company, and meantime it has the privilege of constructing subways for itself, the owners of these conduits agreeing to take them up and place them in such subway at their own expense, if ordered to do so by the Board of Aldermen. It will be seen that this is a very liberal and comprehensive franchise, but I now learn, as I write, that Mayor O'Brien, of Boston, has vetoed the order of the aldermen conferring it. He says that it is illegal, and that, therefore, he cannot pass it. I do not know what is to be done in this case, but it is possible that the aldermen may pass the ordinance again over the Mayor's veto. Boston is not the only large city in this country where this question is being agitated. I hear that in Cincinnati there are several ordinances before the Local Board, most of which ask for exclusive rights from the city, and there again we shall probably see a prolonged and bitter fight.

In New York, with the coming of Spring, there is a resumption of subway work by the Board of Electrical Control; but the trouble now lies not so much in building new conduits as in getting the old ones filled. Many electrical companies refuse to have anything to do with the conduits; they will neither pay for them nor go into them, and the consequence is that the conduits are now, for the most part, lying idle. Thus the Board, with its subways, is left very much in the attitude of Marianna of the Moated Grange. Another matter electrical that is exciting a good deal of attention just now in New York is the recent award made to the Teleseme Company by the Police Commissioners for a service of police alarm boxes. Several of the disappointed competitors are claiming to be heard again. One of the commissioners denounces the vote of his fellows as a job. The magnitude of the prize at stake—the total sum to be invested reaching, it is said, about £400,000—with the opportunity of carrying on a general public service at rental, is the explanation of all the trouble and turmoil in this matter.

The bearing of gas companies towards the electric light has always been a matter of considerable interest and importance. I may be wrong, but it seems to me there is more liberality and enterprise in this respect on the part of the gas companies of America than of those in England; and the situation is somewhat paradoxical, because in England, as far as we can make out, especially from the gas journals, the electric light is anything but the success it should be, and hence is not to be feared, while in America the growth of the electric-lighting industry has been something terrific, and thus the gas people might excuse themselves for being hotly antagonistic to it. Of course here and there instances will be found of sharp conflict between the two interests, and I suppose those cases will continue with us for many years to come; but in a great many other places the *modus vivendi* has been found in a peaceful compact, or a combination of the two interests, or even by the entry of the gas company itself into the electric light field. Some idea of the extent to which gas companies have gone into electric lighting may be formed from a statement recently made by the Thomson-Houston Company, to the effect that the gas companies in this country are now operating over 6,000 of their arc lamps. Another company, the American, has always been very warm in its advocacy of combination everywhere of the two interests. Old gas men are prominent in its management, and it has supplied a very large number of lamps to gas companies. The same may be said of several of the large arc lamp producers, such as the Brush and United States Companies together. I have no doubt that

the manufacturers of arc-lighting apparatus would be sorry to lose their customers in the gas field. This use of the arc light, which has been noticeable for some time, is now being supplemented by the patronage of the incandescent, and I hear of gas companies in all parts of the country putting in incandescent plants, which in several cases are of the alternating system. It is possible that in some instances the gas companies have done this in order to keep the lighting field to themselves; but I think it safe to assume that in the vast majority of instances they have gone into electricity as a legitimate business, and in that we ought all to rejoice for the extension it gives to the field.

The chances seem to be very much in favour of the adoption of a system of electrical execution in this State. In spite of the objections raised in many quarters, including your own, the Bill providing that executions shall hereafter be carried out by means of electricity, and under conditions of secrecy, as proposed by the special commission appointed to consider the subject, passed the New York Assembly this week with scarcely a vote against it, the proportion in favour being about 10 to 1. The Bill has been hardly amended at all, and the conditions with regard to electricity remain practically intact. Knowing what you do of American journalistic enterprise, you will not be surprised to learn that several criminals under sentence of death have been interviewed as to what they think about it, and it appears that they are all in favour of electricity as a means of "happy despatch." I do not know how they have arrived at their conclusions, but they seem to take it for granted that because it is to be less revolting to the public sense it is therefore to be less painful to the person on whom the sentence is inflicted.

Another piece of legislation in this State which is of general interest is the Bill proposing to cut down telephone rates in New York and Brooklyn. The present rate in New York is 150dols. a year. This Bill fixes the maximum charges in the sister cities at 6dols. a month, and in all other parts of the State at 4dols. a month, with the provision that if the telephone is more than a mile away from the central office, 1dol. extra per month may be charged for each mile. This measure has been favourably reported to the State Senate by the committee having it in charge, but probably will not go very much further. In other States measures of this kind have been carried through, with results disagreeable alike to the telephone companies and their subscribers, and the effort in New York has already failed so often that its lack of success may be once more counted upon. These Bills are nothing more or less than what are known here in the slang of politics as "strikes," intended simply to bleed the companies or persons at whom they are directed.

An important decision has been rendered this week at Detroit in the case of a lamp trimmer who received a shock from one of the arc-light towers of the local Brush Company. The shock so upset his nervous system that he has, it is said, since been unable to work. He therefore brought a suit for 25,000dols. damage against the company. The defence was that the man had been careless, and in substantiation of this point a small electric light tower was introduced in court with which experiments were made to show that a careful man would not receive any shock. The complainant alleged that this was not a fair test of the shock he had received, as a current lost its effect when received by a person standing on a dry floor instead of on damp earth or an iron footing. The jury thereupon gave him a verdict for 10,000dols. The company in question is one of the largest and best in the country; but is understood to have adopted the practice in connection with its tower service of running two of its large arc machines in series, thus getting an unusually high electomotive force, rendering the liability to accident greater than would be the case in ordinary street service. Still, it is supposed that the men going to their work are familiar with the conditions, and therefore would adopt such simple precautions for safety as are necessary. In New York here we have recently had a sad case of accident, in which a little pedlar boy unwound a broken telegraph wire from a pole, and received at once a shock so severe that he died soon after. It has not been proved that he had any reason or right for touching the wire; but the accident goes to show how easily sometimes, with defective conditions of insulation, ordinary telegraph and telephone wires, or innocent-looking "dead" wires, may be charged with a fearful potentiality for mischief. Our companies are gradually learning the lesson that it is easier and cheaper to spend one dollar for good insulation than five times as much for compensation in case of injury to person or property. The blizzard left so many broken wires, the clearing away of which seemed to be nobody's duty in particular, and hence there has been greater liability than usual to accidents of this kind; but I think it may be safely asserted that on the whole the lines are better patrolled, and their insulation is higher than has been the case for some time past.

The prospects of electric railroads and electric power generally continue to improve, and it looks as though we shall enjoy an excellent season in this department. All the companies report themselves as very busy, and in no way troubled by lack of orders. In this city the use of motors is increasing rapidly, and would gain at an even greater rate if the facilities for obtaining current were better. I have heard of several instances lately in which motors have been asked for by persons who were not near the existing electric mains. This trouble, however, has been very quickly overcome, and it will not be long before every power user in New York will be within at least a quarter of a mile of some general source of electric current. It is reported that, owing to the growth of their business, the Daft Company, which is one of the oldest, if not the oldest, to-day in America, in the power business, will move its factory to this city. The company has now several electric railways in successful operation, and has its hands full of new work, and a number of new ones, including that at Meriden, Ct., where the Street Car Company, which lost all its animal service through a fire lately, is to replace with electricity as its sole motive power. In this city the Daft Company, or its representatives, have in regular service about 100 motors of all sizes on both sides of the city, and some of the motors have now been running very satisfactorily for three or four years. It is reported that before long the service will be improved by the erection or occupancy of a large building to be devoted specially to work of this kind.

SWEDISH NOTES.

(FROM OUR CORRESPONDENT.)

STOCKHOLM, *April* 30, 1888.

Negotiations have for some time been pending between the Swedish State Telegraphs and the Bell Telephone Company at Stockholm, with regard to the purchase of the latter. These negotiations have now, however, been discontinued, the managing director of the Stockholm General Telephone Company, who has succeeded in buying the greater portion of the Bell Telephone Company's shares, having intimated that he should oppose the sale.

The town of Vesteras will in all probability soon obtain a central electric lighting station, the gasworks of the town having under contemplation the erection of such a station. A detailed plan has been laid before them by Messrs. Luth and Rossen, electrical engineers, Stockholm, and from a financial point of view there does not appear to be any serious difficulties. To begin with, it is only the intention to supply light for indoor use, the cathedral, the college, the town hall, and several other public buildings being first on the list.

A new manufactory for incandescent lamps has been started at Stockholm, Mr. R. W. Strehlenert having removed to this town from Södertelge, where he for a couple of years has been engaged in partly preparatory work in connection with this manufacture. All the most recent improvements have been taken into account, and the Swedish lamps appear to be quite able to hold their own against foreign competition. On a recent occasion they gave great satisfaction at a ball at the Royal castle. Mr. Strehlenert has succeeded in securing an able staff of men, and is at present turning out some 600 or 700 lamps a week, which number, however, can be raised to 2,000 a week, if required.

CORRESPONDENCE.

THE "PAPERS OF FLEEMING JENKIN."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice that in your journal of the 27th inst. you review the published "Papers of Fleeming Jenkin;" therefore, perhaps you will allow me to say a few words upon the same subject.

Jenkin appears to have freely expressed his opinions on things generally, and has shown that his thoughts took much higher flights than those usually connected with telegraph engineering. My own remarks, however, shall be confined to that subject.

On page 75 of the "Memoir," in a letter dated from Birkenhead, April 18, 1858, he writes :—

"Well, you should know, Mr. ——, having a contract to lay down a submarine telegraph from Sardinia to Africa, failed three times in the attempt. The distance from land to land is about 140 miles. On the first occasion, after proceeding some 70 miles, he had to cut the cable—the cause I forget."

I do not know where Mr. Jenkin got his information; but the facts are these. In July, 1854, Mr. Brett and his then associates successfully laid a very heavily iron-bound six-conductor multiple cable from Spezzia to Corsica, and from Corsica to Sardinia. In the following year he endeavoured to continue the line with the same class of cable from Sardinia to Africa, but failed, owing to the weight of the cable, the depth of the water, the unfavourable state of the weather, and the employment of a towed sailing ship, instead of a steamer, as used in his successes. Mr. Brett consulted too many cooks, an error, if all one reads be true, not confined to electrical science, or to Englishmen, and he paid the usual penalty. Alas! poor Brett, when the history of submarine telegraphy comes to be written your name should take a prominent position among those who have helped to make it a success.

This is, as far as my personal knowledge goes, all that was done there at that time; afterwards I only have information from what I have heard and read, which it is not necessary to quote on this occasion. The letters of Jenkin referring to the work done between Alexandria and Candia are to me very interesting, and confirm my then expressed opinion that it was the eccentricities displayed by the alternate dry and wet hemp (for be it remembered there was no iron wire to control it), and not the faulty core, as stated, that caused the failure. It was useless to point out the many instances in which what is termed the core, "unprotected" either by iron or hemp, had advanced submarine telegraphy, while the blind infatuation which imagined everything else perfection, and the "beastly" core the only cause of the mishaps, did so much to retard it.

In one of these letters, on page 98 of the "Memoir," he says, "The Alexandria cable has again failed; after paying out two-thirds of the distance successfully, an unlucky touch in deep water snapped the line." In another letter, given on the following page, he says, "Once it broke inside the ship, but I seized hold of it in time, the weight being hardly anything, and the line for the nonce was saved."

It was fortunate for Jenkin that I was ignorant of these letters when we discussed those matters. I do not know what he means by "an unlucky *touch* in deep water."

At page 229 of the second volume, in speaking of the 1866 expedition, Jenkin states: "The arrangements worked as well in practice as they were admirable in theory. Fortunately no fault occurred." The fact is that fortunately a fault did occur. I say fortunately advisedly, for it proved much, giving us another instance of how well the splendid ship was under the control of Captain (now Sir James) Anderson and his officers. The big ship moved like a thing of life endowed with reason, and seemed fully to enter into the hopes and fears of all concerned. My system of electrical arrangements, which I had adopted for ship and shore, proved to be perfect, and enabled the fault to be thoroughly examined at our leisure. The fault developed itself at 6 a.m. The "Great Eastern" was immediately stopped, the cable cut in the tank a few turns from the sea portion, and the fault found to be in those turns. A section coiled in another tank was spliced on to the sea portion, and before 8 a.m. paying-out was resumed, and all was working as before, continuing to do so until success crowned our efforts.

In the unsuccessful expedition of 1865 I was almost "sent to Coventry" because I would not embrace the "malice" theory, to account for the fault which occurred during the submersion of 1,200 miles of that unfortunate cable. I then firmly asserted my belief that the hemp concealed a break in the wire, which it enclosed, and that the broken wire being bent in coiling, penetrated the hemp and gutta-percha of the coil beneath it.

That being the case in my opinion, I took care when we had at last caught a fault to carefully investigate it, more especially as it occurred in a portion of the cable which it had been intended to lay in the previous year, and consequently it had been coiled on board the "Great Eastern" and passed as good for 18 months. By careful manipulation the fault was found to be caused by the one end of a broken wire in one of the uppermost laps getting bent, and entering the gutta-percha of the lap immediately beneath it, the tread of the "cable hand" over it being sufficient to press the wire to the conductor. No doubt the faults of 1865, which led to such a disastrous termination, were caused in this way.

Now that I am on my hobby I should like to ride it further, did not the fear of trespassing upon your space oblige me to refrain from so doing.—Yours, &c.,

April 30th, 1888. WILLOUGHBY SMITH.

ALTERNATE-CURRENT TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue Prof. Perry is reported to have said, in the discussion of a Paper by Mr. Sumpner at the Physical Society, that I had asserted that the ripples in an alternate current are increased by a transformer. Allow me to correct this. I never made such an assertion, nor did I take any part in the discussion of the subject when it came before the Society of Telegraph-Engineers. I remember the statement being made, and I was at the time rather surprised at its being discussed seriously, as it seemed to me that it must be against the nature of inductional action to do anything of the kind. I should as soon have expected a hose-pipe to increase the pulsations in a stream of water flowing through it.—Yours, &c.,

London, S.E., May 1, 1888. W. M. MORDEY.

[We learn from Prof. Perry that he mentioned the name of Mr. Evershed, not Mr. Mordey.—ED. *E.*]

SELF-INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In response to Dr. Lodge's letter I beg leave to state that the report of my Paper on "The Variation of the Coefficient of Induction" is only a brief summary of the general conclusions arrived at. The experimental part of the Paper, which forms by far the greater portion, is omitted in the abstract.

The statement to which Dr. Lodge more particularly refers can easily be verified mathematically. If a condenser of capacity K, charged to a potential V_0, have its terminals connected by a wire of resistance R, and having a coefficient of self-induction L, the potential of the condenser at any subsequent time t, will be given by one of the following equations:—

$$(1) \quad \frac{V}{V_0} = \frac{T_1}{T_1 - T_2} \epsilon^{-\frac{t}{T_1}} - \frac{T_2}{T_1 - T_2} e^{-\frac{t}{T_2}},$$

$$(2) \quad \frac{V}{V_0} = e^{-\frac{Rt}{2L}} \left(\frac{\sin(\alpha t + \beta)}{\sin \beta} \right).$$

The first equation is to be taken when L is less than $\frac{K R^2}{4}$ and the second when L is greater than this value.

In the first equation T_1 and T_2 are the two quantities whose sum is K R and whose product is K L. Both quantities are positive, and T_1, the larger, is necessarily less than K R. The potential V will depend chiefly on

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the values of the exponentials $e^{-\frac{t}{T_1}}$ or $e^{-\frac{RT}{2L}}$. If it is allowable to neglect the quantity e^{-10} in comparison with unity, the condenser may be regarded as completely discharged in a time $10\,T_1$, if L is less than $\frac{1}{4}$ K R², and in a time $10\,\frac{2\,L}{R}$ if L is more than this value. As these quantities are each less than 10 K R, provided L is less than $\frac{1}{4}$ K R^2, it follows that for such values of L the discharge will take place more rapidly in consequence of the presence of self-induction in the circuit.—Yours, &c.,

W. E. SUMPNER.

Central Institution, Exhibition-road, London, S.W., May 2nd, 1888.

D'ARSONVAL'S GALVANOMETER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to point out that the galvanometer designed by Dr. A. D'Arsonval, of which you print a description, translated from *La Lumière Electrique*, in your issue of the 13th inst., is by no means the proportional reading instrument which its inventor assumes it to be. I say assumes because I do not think he can have made any accurate experiments with it. Obviously, if the instrument is to be a proportionally reading one, the magnetic field in which the conductor moves must be uniform; and this a glance at the sketches will show is by no means the case in the instruments described, and also that it would be a very tedious and difficult matter to proportion the distances and varying thicknesses of the cylindrical pole-pieces so as to obtain a uniform field.

Why it is not necessary for Dr. A. D'Arsonval to say that the instrument is absolutely dead beat is quite past understanding if he wants anyone to think it is so; but one feels glad he is not at the necessity of saying what would be manifestly inaccurate. Dr. A. D'Arsonval has no doubt displayed considerable ingenuity in the design of his galvanometer, and a useful instrument might be made on similar lines.—Yours, &c.,

Lisbon, 19th April, 1888. W. B. SAYERS.

LIGHTNING PROTECTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With regard to your notes on the damage done to instruments by lightning at Porthcurno on the 14th February, I think many of your readers would be glad of fuller information. I, for one, am at a loss to know what did actually happen. It would appear that the damage was caused by a direct lightning discharge—a very unusual occurrence.

With regard to the Siemens plate protector, I think it has been for many years recognised that this, although affording absolute protection to a submarine cable, is hardly sensitive enough to prevent the fusion of such delicate coils as those of the recorder.—Yours, &c., EDWARD STALLIBRASS.

25, Great George-street, April 28th, 1888.

[With regard to our note on the "Saunders" lightning protector in connection with the incident referred to, we gave the name of the inventor as Mr. W. Saunders instead of Mr. H. A. C. Saunders (of the Eastern Telegraph Company). We should be pleased to receive from Porthcurno the further details for which our correspondent inquires.—ED. *E.*]

ELECTRIC GAS LIGHTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have a static induction gas lighter which is at present out of order through the want of new collecting brushes. Would some of the readers of your valuable paper kindly tell me where I may obtain exceedingly thin metal, similar to that used for the collecting brushes of the above kind of gas lighter? Trusting I am not asking too much.—Yours, &c., R. H. W.

[In reply to the above query, a correspondent writes as follows:—"Smith and Son, St. John-street-square, Clerkenwell, or Harrison, of Drury-lane, would be the most likely places. If they have none thin enough he could get some rolled down on purpose at Knight's Flattening Mills, Clerkenwell-close."]

RESISTANCE COILS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I note that my letter, as printed in your issue of April 13th, has one error which, perhaps, it is worth while to call attention to. It reads, "and in case of 10-ohm coils the difference is a very considerable percentage of the whole." It should be, "in case of one-tenth ohm coils, the difference," &c.—Yours, &c., WM. A. ANTHONY.

April 23, 1888.

LONG-DISTANCE TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I shall be glad if you can find space in your valuable journal for the following information under the above head:—

Through the courtesy of Mr. H. F. Jackson, of the National Telephone Company, I recently had the pleasure of speaking over the Sheffield to Manchester and Liverpool trunk line, distance 144½ miles. Only 35 to 40 seconds elapsed before I was in direct communication with Manchester, and after finishing conversation I was switched on to Liverpool in about the same space of time. To both places the conversation was carried on just as easily as if we were only a mile distant. I was also in communication with Leeds and Bradford in similar time. I marked the easy and rapid manner in which the switching was carried out to each town. Having been district manager for the National Telephone Company's Nottingham division for a period of seven years, I can speak from experience upon this subject. I failed to find the slightest interruption from induction influence. I understand that the longest trunk line in Great Britain is from Sheffield to Fleetwood.

As soon as Sheffield is in communication with Nottingham—and this line is now being built—the distance from Nottingham to Liverpool will exceed 200 miles as the line will run. Birmingham is also being connected with Nottingham and with Sheffield and North Yorkshire *viâ* Derby and Chesterfield. Such communication to these important centres must be a great boon to the commercial community generally. I may also mention that the service from Glasgow down the West coast and to the Scottish capital is most excellent.

A few weeks since I also had the pleasure of speaking over a long trunk line of the Western Counties Telephone Company, by the kind permission of Mr. H. F. Lewis, the general manager, Bristol, between that ancient city and Llanelly, South Wales, distance 128½ miles, including a cable across the Severn Bridge. Particulars of towns and distances are given below. I was in communication with Swansea within one minute, when, after conversation, I was asked to be switched on to Llanelly. This occupied about 45 seconds. The communication was perfect in every respect.

Mr. Lewis states that the longest distance spoken by them is from Bath to Llanelly, a wire mileage of 142½ miles. The speaking was in every way perfect and commercially good.

I must not forget also that I had the same pleasure extended to me by Mr. C. B. Clay, the General Manager of the Northern District Telephone Company, Sunderland, whose trunk-line system I also give below. I found the switching similar in space of time as over other systems. I failed to observe any induction over any section of the trunk lines, which are erected on the twisted metallic circuit system. The wires in Yorkshire and Lancashire, however, are all single, and at the time of my trial were perfectly quiet, though I am informed that there is generally some induction disturbance, though so slight as to be of no practical consequence.

While speaking between Sunderland, Newcastle, Middlesborough, Darlington, and intermediate stations, a heavy thunderstorm was reported from these stations; but no interruption was observable, and the conversation, switching, &c., was carried out without the slightest difficulty.

The National Telephone Company for their local exchanges for the past five years or more have used bronze wire, manufactured by the Phosphor Bronze Company, Sumner-street, Southwark, London, and similar wire is now, and for some time past has been, exclusively used by the Western Counties, South of England, and Northern District Companies for local

services, and I understand has given unvaried satisfaction, it having great tensile strength, resistance to oxidation and elongation. After a heavy fall of snow or other strain on the wire, it recovers its normal position, which copper or other wire fails to do; and consequently where copper wire is used the cost of maintenance is much heavier, apart from the inconvenience caused to subscribers by the lines being frequently interrupted. As the so-called hard-drawn copper has simply a mechanical strength, being erected in long spans, such as it is impossible to prevent in towns, it gradually loses its strength, whereas bronze wire, after being erected years, remains the same. Mr. Preece's Paper on "Electrical Conductors," read before the Institution of Civil Engineers, on 4th December, 1883, touches upon this point, extract of which is given below.—Yours, &c., JAMES O. FRY.

4, Avenue-villas, Crickleword, N.W., May 1, 1888.

PHOSPHOR BRONZE WIRE.

Diameter.		Weight per mile in lbs.	Elongation per cent.		Breaking Weight in tons per sq. in	Twists in 6in.		Resis. in ohms, at 60° F.		Conductivity. Copper = 100.
Inch	Mm.							Per mile.	Per foot grain.	
·080	2·056	102·65	1·5 : 1·0 / 2·0 : 2·0		27·61	13 : 16	23 : 35	8·6359	0·22258	94·616
·059	1·529	58·651	nil	nil	29·368	21 : 25	27 : 53	15·437	0·22734	92·637
·044	1·133	32·31	nil	nil	47·406	24 : 25	24 : 23	90·333	0·73285	22·826
·036	0·936	22·698	nil	nil	50·07	23 : 19	11 : 22	157·39	1·4375	14·65
·081	2·072	102·17	1·5 : 1·0 / 1·5 : 1 0		29·022 / 27·47	47 : 19	16 : 20	8·5009	0·21807	96·571

INSULATION FOR ARMATURE WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I wish to ask which is the best insulation for armature conductors after being double-cotton covered?—Yours, &c.,

10, West-street, City-road, Bradford, Yorks, E. BENN.
April 17, 1888.

[It is a little difficult to say which is "the best" material for this purpose. Several firms keep the composition of their varnishes secret, but any good india-rubber varnish may be expected to prove satisfactory, at any rate for low tensions.—ED. *E.*]

ELECTRICAL LIFEBOATS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Electrical power is looked forward to as the agency for lifeboats in the near future. The Council of this Exhibition has two handsome money prizes to offer for the best lifeboats, steam, electrical, or rowing, and we think that some of your readers might be able to exhibit some electrical machinery well adapted to propel lifeboats against adverse winds and tides. The prizes alluded to are the gift of the proprietors of "Cherry Blossom," and no doubt others will come forward for so humanitarian a purpose as saving life from loss at sea, which amounts to something approaching 5,000 each year.—Yours, &c.

F. JOHNSON, Manager,
International Maritime Exhibition.

Alexandra Palace, April 25, 1888.

ART GALLERIES LIT BY ELECTRICITY.

A correspondent asks us to furnish a list of the Art Galleries in the United Kingdom which are lit by the electric light. The following are all that occur to us at the moment, and we shall be glad if our readers will enable us to make the list complete:—

South Kensington.
The Grosvenor Gallery.
Institute of Painters in Water Colours.
Birmingham Corporation Art Gallery.
Hastings.

At the Liverpool Gallery, we believe, the light has been discontinued.

TELEGRAPHIC COMMUNICATION WITH THE PHILIPPINE ISLANDS.

The following is a translation of an article which recently appeared in the Spanish journal *La Paz*:—

"In a limited article like this it is impossible to deal properly with such a wide question as the necessity for submarine cables in the Philippine Archipelago. However, when we mention that not a single cable is in existence as a means of communication between island and island nothing that is said can seem out of place. During the last few years several grave events which have occurred in these distant islands have forcibly demonstrated the tremendous inconvenience of the non-existence of rapid modern means of communication. Not only was His Majesty's Government in the dark, but the very Colonial officials themselves lived in ignorance of what was taking place in the far distant corners of the Archipelago. This state of things still exists, as we have but recently seen. Under such lamentable conditions good government is impossible. The general torpor engendered by such slow means of communication results in every occurrence coming as a bolt out of the blue; all remedies come too late, all public and private enterprise is stifled. If we have cited a few of the reasons why the Government should have cables laid, we must not forget the urgent needs of those interested in the commercial prosperity of the islands. The necessity for promptly laying submarine cables is so obvious and so generally admitted that it seems superfluous to enlarge upon the theme. What prevents the realisation of this idea? Is any private interest or privilege menaced, explaining though not justifying this delay? Not one! Is it that the exchequer of the Archipelago is unable to bear the expense of a cable? Certainly not; let the word be spoken, and the cable will be laid. Well, but there is something explaining this eternal delay. Yes, the baneful and terrible slowness of all official reports, travelling as they do from Spain to the Philippine Islands, then home again, and once more back to the East to be examined here and out there by governmental, financial, technical, consulting authorities, &c.

"A few years ago some of the irresistible arguments set forth above caused the Government to think of having a cable laid down between Manila and Zolo, in order to connect the isolated and distant isles of the Archipelago; for isolated they are, in spite of their proximity to one another. The cable mileage requisite is some 700, distributed as follows:—200 from Luzon to Cebri, touching at Panay and Negros; 300 from Cebri to Zamboanga (Mindanas); 100 from Zamboanga to Zolo. The cost of a nautical mile of cable may be reckoned at £220, which was the contract price for the Hong Kong-Luzon cable. Time has shown that the choice made by Señor Eldnazen in the Royal decree of the 22nd Feb., 1879, was a most judicious one. The company chosen is the only one possessing telegraph ships in those regions, ready to repair at a moment's notice any injured cable, besides which it had already more than 50,000 miles of cable at work in 1879. This company, whose position defies competition, was then and is now the only possible one. This company could lay the necessary cables in a very short space of time, dispensing with the official investigations, which are almost as costly as the cables themselves. The cables could be laid by the trained staff of the company from its own telegraph ships; everything, in short, would be done, once and for all, gratuitously and economically for the State. The same clauses relating to the free transmission of Government messages, &c., inserted in the case of the Hong Kong-Luzon cable, could be insisted upon now, and the desired object attained directly. Nevertheless we are sadly afraid that the cable will, as yet, only be laid down in official documents. And this will be so, not because Señor Balaguer is lacking in affection for the Philippines, but because we fear that he himself is now getting enveloped in the fatal meshes of bureaucracy, which strangle the best intentions and render the grandest ideas sterile."

PRIESTMAN'S PETROLEUM ENGINE.

Messrs. Priestman Brothers are exhibiting at their show room, 73A, Queen Victoria-street, a new petroleum engine, which is driving a dynamo for electric lighting. A larger engine of the same type, about seven or eight horse-power, is working at the Electrical Power Storage Company's Works, Millwall, charging accumulators.

This engine uses only the ordinary petroleum of commerce, and is therefore free from the objections raised against the use of engines employing highly inflammable spirits, such as benzoline and gasoline.

It is very simple in construction, having few working parts. The oil from which the motive power is obtained is placed in a closed iron tank inside the foundation; air is pumped into the tank until

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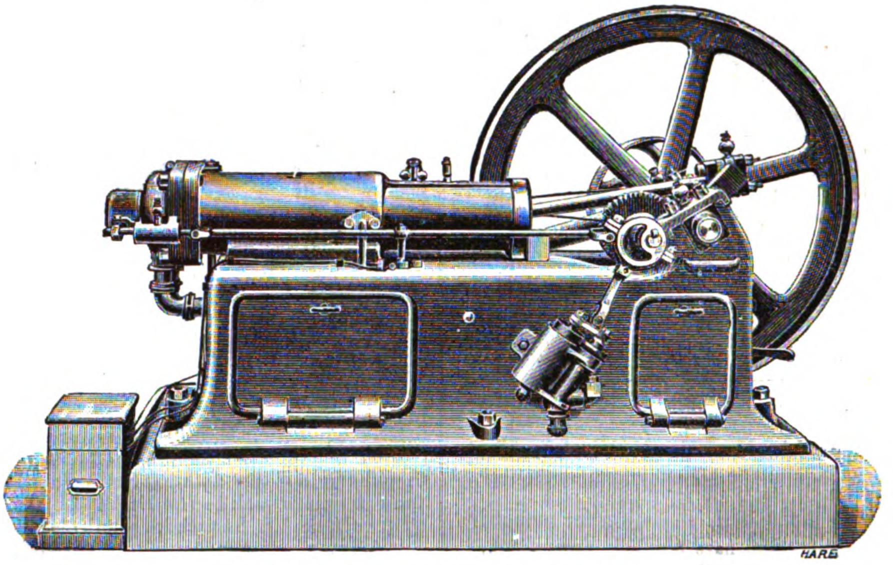
a pressure is obtained of about five pounds to the square inch. The oil is then mixed with air until it is formed into a vapour, after which it is passed into a closed iron vessel or vaporiser, where it is heated, and from which it is admitted into the cylinder, and ignited by means of an electric spark, which is obtained from a small primary battery. An explosion is obtained at every second revolution. The battery is capable of doing about 30 hours' work without attention, but we think that the makers would find a small magneto machine more convenient for the purpose.

To start the engine it is only necessary to heat the vaporiser for a few minutes, and take a turn or two of the fly-wheel, after which the required heat is obtained by utilising the heat from the exhaust products.

engine requires no coal or gas it can be fixed and worked where other motors could not be employed.

The great difficulties to be overcome in perfecting a reliable engine using only common petroleum oil have long been recognised, but judging from what we have been able to learn of its performance in the hands of independent users there seems to be every reason to believe that those difficulties have at length been successfully overcome.

There is a special opening for a motor of this kind for electric lighting in country places where gas is costly or not obtainable, little progress having been made hitherto in introducing the electric light in districts where it is most required, for lack of a suitable motor.



PRIESTMAN'S PETROLEUM ENGINE.

The cost of working this engine, taking oil at the present price, is said to be a little more than ½d. per indicated horse-power per hour.

No driver is required, there is of course no boiler, and as the

No extra charge is made for insurance, &c., where this engine is placed, and no license is required, as in the case of an engine using inflammable oil. The safety of using this oil is proved by the fact that a lighted match may be thrown into it without causing ignition.

BOOKS, &c., RECEIVED.

"Merchandise Marks Act." A complete digest. By H. C. RICHARDS and H. SMITH. (London: *Warehouseman and Drapers' Trade Journal* Office.)

"List of Subscribers of the National Telephone Company (Limited)." Dundee and District. (Dundee: ROBERT S. BARRIE.)

"The Engineering Directory." (London: Bedford-street, Strand.)

"Report of the New England Insurance Exchange Electric Light Committee." (Boston: Frank Wood, 1887.)

"*Journal* of the Society of Telegraph-Engineers and Electricians." No. 72, Vol. XVII. (London: E. and F. N. Spon.)

"*Transactions* of the American Institute of Electrical Engineers." Vol. V., No. 6. (New York.)

COMPANIES' MEETINGS & REPORTS.

Eastern Extension, Australasia, and China Telegraph Company (Limited).

The twenty-ninth ordinary general meeting of the shareholders in this Company was held on April 25th, at Winchester House, Old Broad-street, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting, and the minutes of the last meeting, which were approved by the present meeting, and signed as correct by the Chairman. The report of the Directors was taken as read.

The CHAIRMAN: I shall, as has usually been my custom, go over some figures in the report, so that I may give you the opportunity of putting any questions and getting such explanations as it has always been my pleasure to give you. The gross receipts for the half-year have amounted to £232,660, against £216,956 for the corresponding period of 1886, or an increase of £15,704. The working expenses for the half-year amounted to £69,570, against £80,066 for the corresponding period of 1886, showing a decrease of £10,496, which is mainly due to the cost of repairs to cables being lighter during the past half-year than in the corresponding period of 1886. The net revenue for the half-year amounted to £117,889, against £91,070 in the corresponding period of 1886, showing an increase of £26,819. Comparing the figures for the whole year, the results are as follows:—Gross receipts in 1887 £451,861, against £441,799 in 1886, showing an increase of £10,062. The working expenses in 1887 were £145,812, against £161,841 in 1886, showing a decrease of £16,029. One interim dividend of 1¼ per cent. has been paid for the half-year, and it is proposed to pay another of like amount to-morrow, making, with the interim dividends for the first half-year, a total dividend of 5 per cent. It is also proposed to distribute a bonus of 3s. per share, which will make a total payment of 6½ per cent. for the past year, against 6 per cent. for the previous year. The balance of £53,051 has been carried to the general reserve fund, which now stands at £620,095, as shown by the following figures:—Amount of fund at end of 1886 £569,440, interest added during the year £20,363, balance of revenue £53,051, making a total of £642,854, from which has been deducted the cost of a further partial renewal of the Singapore-Saigon and the Penang-Rangoon cables £22,759, leaving a balance of £620,095. The net result, therefore, of the past year's working is that the reserve fund has been increased by £50,000; the further partial renewals of the Singapore-Saigon and Penang-Rangoon cables have been paid for out of revenue, and 6½ per cent. distributed amongst the shareholders. Now, gentlemen, I think you will agree with me that that is a very satisfactory statement to put before you to-day, and when I tell you that we have recouped ourselves to a considerable extent the reductions in the tariff which we made at the Berlin Conference, I think the position of the Company may be said to be as prosperous almost as we could fairly expect it to be. There is a feature in connection with our large reserve fund that I should like to point out. We had a suggestion, by the way, from one of our shareholders, that we should re-value our securities and pay the excess over the original cost as a bonus to the shareholders. I must say that while I am always pleased to pay bonuses when we can do so with some reason, I am afraid that there would be no good reason for paying a bonus out of the premiums shown on the re-valuation of the securities in which the reserve fund is invested. As an illustration of that, I may mention that a month or six weeks ago the increased value of those securities was something like £75,000; but if we had paid that £75,000 away I am afraid we should have required to ask

you to refund it, because the extreme prices which enabled us to show that premium were more or less the result of the change that was taking place owing to Mr. Goschen's scheme for the conversion of the National Debt. That caused a rush for other securities, and the result was that there was a very considerable increase in the prices. Still, to-day there is the substantial sum of £50,000 profit on the securities in which our reserve fund is invested. There is another good feature that I am pleased to bring before you, that further drawings of the Company's Five per Cent. Debentures have taken place since the close of the half-year, and the capitals outstanding have thus been reduced as follows:—The original £100,000 of the Five per Cent. issue of 1880 has been reduced to £24,400, and the £640,000 of Australian Government Subsidy Five per Cent. Debentures have been reduced to £446,000 by annual drawings. Therefore, while we are increasing the reserve fund we are decreasing our capital liabilities. The question of cable renewals is also one which requires a good deal of consideration. The completion of the renewal of the Singapore-Saigon section with brass-ribboned cable has been carried out since the close of the half-year, the cost of which, amounting to about £17,000, will be dealt with in the accounts for the current half-year. This gives us a new cable, entirely brass-ribboned, between Singapore and Saigon, paid for out of revenue. Therefore, you see, we are strengthening our position in every way; we are strengthening our power of carrying on the work; we are strengthening our position as a Company to defy almost any competition; and I believe the only way to maintain the position which we occupy at the present moment is to do our work better than it would be possible for any other company to do it. During the coming year we have still important work to carry out. We purpose effecting important alterations in the Madras-Penang cable at the Nicobar Islands, and in the Java-Australian cables off the Lombok Strait, where we have frequently had difficult and costly repairs. These changes will probably cost £75,000, but it is anticipated that they will effect considerable improvement in the working, and a large saving in the cost of repairs. If we had our cables laid on such ground that no repairs were required, we should be able to pay a very much larger dividend than we are now paying, but the cost of maintaining the cables is a very serious item in our accounts. As, however, I have said before, we have duplicated most of our cables; and at the same time we have not to any great extent increased our capital. This duplication of our cables gives us such security in carrying our traffic that you never hear, or scarcely ever hear, of any interruption in our telegraphic communications. That is the real source of our strength, and that we shall endeavour to maintain as long as we have the confidence of our shareholders. I have mentioned on one or two occasions the difference we have had with the New Zealand Government in regard to the renewal of their subsidy. I dare say you have all observed in the papers that the financial condition of that colony has not been as prosperous as we would wish to see it or as its friends would wish it to be. New Zealand has a grand future, but at the present time they have probably spent a little more money than was prudent. Probably it would have been better had they spread the expenditure over a longer period. Nevertheless, the work is done, and it will help materially in developing New Zealand, and I have no doubt that before long we shall see the colony in the prosperous position she once occupied. At the same time it has made her very careful in her expenditure, and the result has been that the Ministry did not feel disposed to put before their Parliament the question of renewing their subsidy. Consequently, we had to take the next best course, and increase our tariff so as to recoup us to some extent for the loss of the subsidy. That measure shows the importance of our system. Notwithstanding the increased charge we made—which, I may say, was not much objected to on the part of the New Zealand Government—we have had an increase in the number of words over our cables, showing that telegraphic communication has become an absolute necessity. The result has been that we have nearly recouped the loss of the subsidy out of the traffic at the increased tariff. The next question that may interest you is in regard to our relations with China. When I had the pleasure of addressing you six months ago I mentioned that we had been negotiating with the Chinese Government, and that the negotiations were practically finished. The agreement is, however, still unratified by the Central Government; but the Chinese never move very quickly, and we are perfectly satisfied to wait their pleasure, as by waiting we are enabled to put money into our own exchequer which we should otherwise have to pay to the Chinese. We have also heard a good deal about opposition in the Pacific. That may come some day. I never say that anything is impossible. They have now decided to take soundings, which will probably extend over a period of three years, so that for that time at least we shall not be troubled with an opposition line viâ the Pacific. Should the question arise again, I hope that our position will enable us to deal with it in such a way as will not make it possible, or, at all events, possible in any way to annoy or inconvenience us. There is another matter I think it is right you should know, as we are always anxious to give our shareholders the fullest possible information. Western Australia, though not one of the leading colonies, is very anxious to have direct communication with this country, and the Government of Western Australia have received an offer from some of their people to help them to attain that end. We are equally disposed to take this view, if it is necessary; and if we find that we can carry it out with advantage to them and to ourselves, we shall not lose sight of it. We are at the present moment looking into the question, and possibly when I meet you some months hence I shall be able to tell you that we have made some arrangement with that colony. Since I last addressed you we have completed an arrangement with the Netherlands-Indian Government for a cable of 462 miles between Java, Baly and Macassar. They pay for the cable, and it will be a feeder to our system, and with that object in view we have done everything we possibly could to assist them. I have one more duty to fulfil, and that is to express the great regret of the Board at the death of one of its colleagues, Sir William M'Arthur. He was associated with this Company from its inception, and was a most useful member of the Board. He was well known not only in the colonies, but also at home. He was a thorough man of business, and was constantly doing good works. With these remarks I beg to move:—

"*That the report and accounts of the Directors now submitted be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 3s. per share, both free of income-tax, payable on the 26th inst., making, with the previous distributions, a total payment of 6½ per cent. for the year 1887*"

The Marquis of TWEEDDALE: I have great pleasure in seconding the motion.

The CHAIRMAN: If any gentleman has any remarks to make I shall be glad to hear them. No one rising to address the meeting, he put the motion in the usual way, and declared it carried unanimously. Continuing, he proposed the following resolution:—

"*That John Denison Pender, Esq., who now retires by rotation, be and is hereby re-elected a Director of this Company.*"

Sir JAMES ANDERSON: I have much pleasure in seconding that.

The CHAIRMAN put the motion in the usual way, and having declared it carried unanimously, added: I may say that Mr. John Denison Pender is my son, and I am anxious that I should have my son following to some extent in the footsteps of his father. I am getting on in life, and I desire my son to know thoroughly the wants and the duties of a concern like this. Although he is a comparatively young man, yet he is very much older than I was when I took much more serious responsibilities on my shoulders than I have even at the present time. I am pleased that you have accepted my son in the place of the late Sir William M'Arthur, and I only hope that he will prove equal to his duties. If he does not he is now taking a position in which he must be judged by his own merits.

Mr. J. D. PENDER: I beg to thank you, gentlemen, for electing me a Director.

The CHAIRMAN: The next resolution is

"*That the Most Hon. the Marquis of Tweeddale, who now retires by rotation, be and is hereby re-elected a Director of the Company.*"

Lord Tweeddale has been with the Company from the beginning. He is one of the band of men who have worked earnestly and honestly in the promotion of submarine telegraphy; and, as I have said before, when the history of submarine telegraphy is written, Lord Tweeddale's name will be associated with it as one of its principal promoters.

Mr. BEVAN: I have great pleasure in seconding the motion—which was carried unanimously.

The MARQUIS OF TWEEDDALE: I beg to thank you, gentlemen.

Mr. VARLEY: I have great pleasure in proposing

"*That Mr. Henry Dever and Messrs. Quilter, Welton and Co., be and are hereby re-elected auditors for the ensuing year, at a remuneration of £100 each.*"

Mr. KING: I beg to second the motion—which was carried unanimously.

The CHAIRMAN having intimated that that closed the business of the meeting,

Mr. VARLEY said: I think the least we can do is to move a vote of thanks to the Chairman and the Directors for their services. They have presented us with an admirable report. The Chairman anticipated one of the remarks I had intended to make as to the immense increase in the value of the reserve fund. He mentioned also that there had been a little falling off, but I have no doubt that that will be recovered again. I do not believe that leading debenture stocks will ever go back to the prices at which they stood a short time since. Our Six per Cent. Debentures fall in in a few years, and I think we shall gain by that something like £6,000 a year in replacing them.

The resolution was seconded, and carried unanimously.

The CHAIRMAN: On behalf of my colleagues and myself, I return you our most hearty thanks for your continued support and appreciation of our labours. I really feel that our Company is in a very healthy position, and looking at the fall in securities in many directions, I think that it affords a very fine investment indeed, because we are now demonstrating that it *is* a property. Although it is at the bottom of the sea we can keep it in constant working order, and in a position to earn a good dividend; and it will be our duty, as it will be our pleasure, to continue to pay you as large a dividend as we can.

The meeting then terminated.

The London Platino-Brazilian Company (Limited).

An extraordinary general meeting of shareholders of the Company was held at the offices of the Company, Winchester House, Old Broad-street, London, E.C., on Friday, the 27th April, 1888, for the purpose of considering and, if deemed desirable, passing a resolution approving an agreement, dated 18th April, 1888, entered into by the Directors of the Company with the Western and Brazilian Company (Limited), and authorising the Directors to carry the same into effect. Sir John Pender, K.C.M.G., chairman, presided.

The CHAIRMAN said: Gentlemen, the secretary will read the notice convening the meeting.

The SECRETARY (Mr. William Payton) having read the notice,

The CHAIRMAN said: Gentlemen, this being an extraordinary general meeting, called for an express purpose, I will call upon the solicitor to read the agreement which in the few remarks I intend afterwards to make I shall recommend for your acceptance.

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The SOLICITOR (Mr. Norton) having accordingly read the agreement,

The CHAIRMAN said: Gentlemen, you have heard the agreement read, and I shall now read the resolution which I have to propose, after which I shall make some remarks on the present position of the Company and lay before you the reasons which have induced the Board of this Company to bring this proposition before you and recommend it to you for acceptance:—

"*Resolved, that the provisional agreement, dated the 18th day of April, 1888, made between the Western and Brazilian Company (Limited) of the one part and of the London Platino-Brazilian Company (Limited) of the other part be, and is hereby, approved, and that the Directors are hereby authorised to do all things necessary to carry the same into effect.*"

Now, gentlemen, before I put the resolution to the meeting I think it is right that I should recall to your memory the history of this Company and the reasons which brought the present Board of Directors into existence. They did not solicit that honour, but they were appealed to by certain shareholders largely interested in the undertaking, which had been brought into a state of chaos, paying nothing and doing nothing, to take it by the hand and endeavour to bring it to something like the position which it ought to occupy among the submarine telegraph systems of the world. We took it up. Captain Pavy and myself took a very prominent part in the formation of the Board, and we called in the very best assistance in our power to carry out the work, and here let me say we could find no better man, and there is no better man to be found to-day, than our friend and colleague, Mr. Hollocombe. The result has been that we have saved this Company from wreck and ruin, and we have brought it into a position in which it is able to make fair and honourable terms with another larger and more powerful company. My experience of submarine telegraph companies teaches me that a small company standing alone can be beneficial neither to itself nor to the public generally, and certainly it cannot be of the same value to its shareholders. The less friction that there is in telegraphy the better. That applies not only to the system of working, but also to the boards. It is not for me to condemn the first agreements that were made by this Company with its promoters and projectors, and the agreements afterwards made with the Western and Brazilian Company. We all know that lawyers sometimes differ, and the lawyers somehow or other, when they made these agreements, did not foresee the difficulties that might arise in the future. That is one of the reasons—not the most important—but that is one of the reasons that has induced your Board to consider whether it is better, not that it should be absorbed, but that the control of this Company should pass into the hands of a larger and more powerful company. Why should we go into a court of law and fight all our points of difference, so as to establish what I may call a proper understanding between the two companies? The Boards of both companies are gentlemen well known to one another. We dislike the law, but we see that recourse to law is absolutely necessary if we continue to work apart (applause). Upon these grounds, gentlemen, we consider it desirable that the two companies should be brought under one control. It is not a question of amalgamation—it is simply a question of our handing over the control of this Company to the Western and Brazilian Company. We shall have practically nothing to do with the management. We are now entitled to a certain percentage—20 per cent. of the gross rates—but they can so manage that they can make that 20 per cent. just what it suits their own convenience and their own interests. (A VOICE: "How?") Because they are entitled, for instance, to make a bargain as to a reduction of rates. They benefit by that reduction of rates. It tells against our interest, but it does not interfere with theirs. It is a point to consider whether in equity that is a fair and a just thing, and might involve us in a lawsuit to establish the particular point. If anyone will take the trouble to read over the original agreement he will find in it the finest matter for a troublesome lawsuit that I have ever seen in my life. We want to avoid law, and we have brought the thing exactly into this position, that those who wish to cling to the old Company can remain with the old Company, and those who desire to let the concern go into the management of a larger company can do so. I have now to point out to you the advantages of the scheme. And, first, let me observe, gentlemen, that I am bound to say, watching it as I have done, that the management of the Western and Brazilian Company has been such as to raise it very considerably in my estimation during the last few years, and therefore I see in the future of that company more power and more profit. It is for that reason that I do not hesitate to recommend to the shareholders of this Company to take three shares of that company for five shares of this Company. The result will be that there will be something like 1 per cent. more in dividend than you are likely to receive from this Company. These are the reasons why we ask you to accept this exchange. I do not press it upon you. I am personally perfectly satisfied to go on and work as we are. I am a considerable shareholder, but I feel, being largely connected with submarine telegraphy, that the more the management can be concentrated the better it will be. I am not going to talk to you as if your property was not as good as theirs. I am not going to tell them that their property is much better than ours; but what I say is that by managing the two companies together we shall make more money than can be done by managing them separately. These are my reasons, and I need not go into further details, for recommending this scheme to you. I am quite willing to explain to anyone anything further; but I think I have said sufficient to show you that the platform on which we now stand is one that justifies us in bringing the scheme before you by which we shall make a bargain which we consider will be equitable and fair to both companies, and which we believe will not only promote the interests of telegraphy generally, but will more particularly add to the profits of the shareholders of the Platino-Brazilian Company. With these remarks I beg to propose that the resolution which I have just read be approved.

Captain FRANCIS PAVY seconded the resolution.

Mr. YOUNG desired to know how it was proposed to deal with the uneven numbers of the shares. He wished further to ascertain what would happen to these shareholders who did not signify their intention by the 20th May of agreeing to the schemes. Were the staff of the Company to be taken over by the Western and Brazilian, and were any of the members of the Board going on to the Board of the other company?

The CHAIRMAN: None of the Directors of the present Board go over to the other Board; I may also say the same thing with regard to the staff.

Mr. YOUNG thought the proposed arrangement was one that should meet with the approval of the shareholders, seeing that by their exchanging five of their shares for three of the Western and Brazilian Company's, there was an advantage of £1 in favour of the Platino-Brazilian shareholders. With regard to law expenses, he detested lawyers, and as the Chairman had pointed out, if they could reconcile two companies that were to a certain extent antagonistic by adopting such a course, he thought it to be in the interest of all concerned to do so.

Mr. FRY, while endorsing everything that had been said with regard to the advisability of the Company being merged into the Western and Brazilian, begged to protest in the strongest possible manner he could against the item of £6,000 which it was proposed to pay the Directors by way of compensation. He had considered the matter over with his friends, and they failed to see any reasonable argument for allowing so large a sum, inasmuch as the Board had been very well paid for the services they had rendered to the Company. He hoped to hear before leaving the room that the Directors were willing to make some modification in the sum proposed to be paid to them.

Mr. GRIFFITH said, in reference to Mr. Young's statement deprecating their having anything to do with lawyers, that he unfortunately belonged to the legal profession (laughter). But it must be borne in mind that there were two species of law—litigation and non-litigious law. Let them avoid litigation by all means if they could, and rather take an honourable compromise when it was proposed than have recourse to it. He did not wish to criticise the agreement in detail, but he questioned whether the shareholders did not incur a serious responsibility in accepting it, because so recently as last year three of the judges in the Court of Appeal endorsed an opinion expressed by Lord Justice Lindley, while still a barrister, to the effect that shares could not be issued at a discount without laying on the shoulders of the holders the onus of being liable to pay, in the event of any future litigation, a call for the full amount of the shares, an obligation which he for one did not feel inclined to undertake. He referred also to another lawsuit in support of this contention. The saving point in the agreement was that they could retain their old shares without entering into the proposed arrangement; but, on the other hand, they lost the able services of the present Directors, inasmuch as the whole management would be transferred to the hands of the Directors of the Western and Brazilian Company, which, to his mind, was a very serious matter.

Mr. WM. FORD said that he had read the cases referred to by Mr. Griffith, and maintained that they were in no sense applicable to the present one. This was not an issue but an exchange of shares at their full value, and therefore he said with the utmost confidence that the shareholders incurred no future liability by way of a call.

The CHAIRMAN in reply, said that with regard to the odd numbers of shares, they would be dealt with either by shares or by money. If three-fourths of the shareholders did not agree to the scheme it naturally would fall to the ground, but judging from the proxies they held and by feeling the pulse of the parties interested, the Directors had no doubt whatever that it would be carried out. Mr. Ford had completely answered Mr. Griffith's objection. This was an exchange and not an issue of shares at all. They had a chance either of remaining in the old Company and seeing their dividends getting visibly smaller, or of entering into the new company and seeing them beautifully increasing. Coming to the point raised by Mr. Fry, he held that the Directors saved the concern from wreck and ruin; that they had made a good bargain for the shareholders by the proposed agreement, and that they handed over the Company to another body of shareholders without asking them to pay a penny for the transaction, because the Directors of the Western and Brazilian Company were prepared to forego their honorarium until the £6,000 compensation was paid off, and therefore, in reason and fairness, the Board were fully entitled to the recompense to which Mr. Fry objected.

Mr. FRY interposed by saying that he considered the admirable services which the Directors had rendered to the Company had been adequately rewarded by the £800 a year which they had drawn.

The CHAIRMAN said that one man might be very well rewarded with 1s. a day where another man would be badly paid with 10s. a day.

Captain PAVY pointed out that a great deal of work had been done by the Directors at one period of the Company's existence for which they had received no pay whatever, and that £6,000, having regard to the £400,000 of capital of the Company, which was greatly improved by what they proposed to do, did not amount to more than 1½ per cent. commission on the transaction.

The SOLICITOR said that the agreement had been carefully prepared by Mr. Kirby, of the Chancery bar, and he could assure the shareholders that they would incur no further responsibility by accepting the agreement.

The CHAIRMAN reminded the meeting that a similar resolution was unanimously adopted at the meeting of the Western and Brazilian Company the previous day, and repeated his opinion that in the interest of the shareholders of both companies the agreement would be of permanent advantage.

The resolution was then put to the meeting and carried, Mr. Griffith alone dissenting.

On the motion of Mr. YOUNG, seconded by Mr. GRIFFITH, a vote of thanks was cordially passed to the Chairman and Directors.

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The CHAIRMAN, in acknowledging the compliment, said that he was sure he expressed the opinion of those who worked with him in bringing their feeble child into a state of manly existence when he said that they would rather have kept that child at home for a time, but seeing that it was better for its interests to go into a wider sphere, they were constrained to part with it. At the same time, they hoped to have a *souvenir* of its existence.

Indo-European Telegraph Company (Limited).

The twenty-first ordinary general meeting of this Company was held at Winchester House, 50, Old Broad-street, on Monday, the 30th ult., Colonel James Holland presiding.

The CHAIRMAN: Gentlemen, I beg to declare the meeting duly constituted, and I will call upon our Managing Director to read the notice calling the meeting.

Mr. W. ANDREWS (Managing Director) read the notice.

The seal of the Company was then affixed to the register of shareholders.

The CHAIRMAN: With regard to the report, I presume, gentlemen, you will take it as read.

The report and accounts were taken as read.

The CHAIRMAN: Gentlemen, these accounts call for very few observations. The revenue is just about the same, namely, £104,290, compared with £104,583. But that does not exhaust the matter, because although the total receipt is the same, it is not quite made up of the same parts. The Indian messages contributed between £6,000 and £7,000 less, and it is a discouraging fact that this traffic, at the reduced rates, ever since the reduction was made, has not reached its former amount, and at the present time still seems inelastic and disappointing. In fact, wherever the reduction of tariff was applied the same unsatisfactory result has happened as far as this Company is concerned. The Company's revenue has, however, fortunately been made up where the Company made no reduction, and by new sources of traffic already reported upon in the proceedings for the year 1886. There is really nothing more to be said with regard to the revenue. As regards the expenses, there is again a considerable decrease, which mainly consists of three items—stationery £472, agency and general expenses £495, and maintenance £1,119. All these are fluctuating items, and next year they may take a turn the other way. The increases are only £359 spread over several items, and are not worth analysis, the net result of the whole being a decreased outlay of £2,152. 12s. 5d. In pursuance of the policy you have approved for some time past we have added £10,000 out of revenue to the reserve fund, which now stands at £102,463, and looking around us we must admit that the provision is only ordinarily prudent. I think, gentlemen, you will agree with that. We are carrying forward a rather larger balance, so should the current year's expenses be somewhat more there is a nest-egg to meet it, and to keep the accounts from fluctuating as nearly as we can. We are believers in a good, steady, regular state of things if arrangements can be made to secure them. Our reserve fund investments, I may tell you, which now stand in our books at £102,463, if sold at last week's prices would fetch about £110,775, showing an increased value of 8$\frac{1}{10}$th per cent. Going into detail a little, the maintenance is very low, without anything having been neglected. But here again the shareholders must be cautioned that at a short notice a larger outlay may have to be made, and that the present figures must by no means be taken as the standard of regular maintenance outlays. The alterations and improvements happen to be very limited this year. The Company's line is in very good order, and has been so throughout the year. The shareholders will have seen by the report that the duplex system has been applied to work either the wire in Reuter's cable or that in the German Union cable between London and Emden. These apparatus were supplied by Messrs. Siemens, and, like all the other work they undertake, were a model of manufacture, and they continue to give perfect satisfaction. They have proved very useful too, and fully justify the prudence of the Company in providing them, for on the breakage of one of the cables the Company has been enabled to do its work practically without delay. Of course, when both cables were in working order the duplex has no work to do. The provision is made to guard against accident. The Company has always endeavoured to keep the system in advance of all requirements of the traffic. There is really nothing further to say, except to move that the report and accounts now submitted be received and adopted, and that a dividend be and is hereby declared for the half-year ended 31st December, 1887, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year.

Mr. J. HERBERT TRITTON: I second that.

The CHAIRMAN: Gentlemen, before putting it to the meeting, I will wait and hear if any gentleman has anything to ask on the subject of the report.

Mr. JACKSON: I should like to ask whether the Directors have any limit with regard to the reserve fund, and as to what amount they will consider to be satisfactory. I am not expressing any opinion upon the policy, but I should like to know, if it is not wrong to state it, if you will tell us what is the limit which, in the opinion of the Board, we should remain at with regard to the reserve fund. I see £10,000 is placed to it this year, so it is now nearly 25 per cent. of the whole capital, and it is a satisfactory reserve fund to meet all the requirements of business. I think a reserve fund is rather an evil than a good when it reaches too high a point. I think we are entitled to the profits which are made beyond this point; we can deal with them, perhaps, more satisfactorily in our pockets than the Directors can by investing it at the low rate of interest which they can get on the securities they hold.

The CHAIRMAN: Gentlemen, that question of the amount of the reserve fund is one which does not come upon us by surprise. It is one which we have fully and frequently discussed amongst ourselves, and I quite agree with the gentleman who has just spoken that 25 per cent. is, as an ordinary rule, a very fair amount of reserve fund. But there are special difficulties connected with this Company which induce us to consider we have not yet fully reached the amount which the reserve fund should show. We all know, it is no secret, for you have only to open a daily paper, and you will see how war is threatening in many parts of Europe. Were war to occur we should be shut up, for Germany and Russia, and Russia, most probably, would be closed to us. Therefore, as far as we can see our way at present, we cannot fix upon any specific amount. All we can say is that we hope the war crisis may be removed, and trade recover its wonted elasticity, and then we may be able to divide a larger amount amongst the shareholders. At the same time I must say that 10 per cent. free of income-tax, and an addition of £10,000 to the reserve fund—which, although it does not go immediately into your breeches pockets, adds very considerably to the value of the shares in the market—is not an inconsiderable amount of dividend. All I can say is that the Directors are anxious to divide more, but as prudent men they must be allowed to exercise their judgment as to the time when the limitation of the reserve fund can occur. I hope that expression of opinion will be satisfactory. I will ask those gentlemen who are in favour of the proposition which I have laid before them, and which has been seconded by Mr. Tritton, to be good enough to hold up their hands.

The resolution for the adoption of the report and accounts was then put and carried.

The CHAIRMAN: I have now, gentlemen, to state that in accordance with the provisions of the Articles of Association, two Directors retire by rotation, namely, Mr. H. Weaver and Mr. A. Delbrück, and I move

"*That Mr. Weaver and Mr. Delbrück be and are hereby re-elected Directors of the Company.*"

Major-General G. B. TREMENHEERE, R.E.: I second that.

The CHAIRMAN: When Mr. Weaver's name is put before you for re-election, it is only just for me to say that we are all well pleased to know that he will continue to give his services to the Board.

The resolution was carried.

Mr. WEAVER: I have to thank you for re-electing me, and I beg to thank the Chairman for the very handsome way in which he has put the proposition.

The CHAIRMAN: I have to state that Messrs. C. F. Kemp, Ford and Co., the Company's auditors, retire by rotation, and offer themselves for re-election.

Mr. STEFFEN: I have pleasure in moving

"*That Messrs. Kemp, Ford and Co. be re-elected auditors for the ensuing year.*"

Mr. JACKSON: I have pleasure in seconding that.

The resolution was put and carried.

The CHAIRMAN: That, gentlemen, concludes the business of the meeting. I would only like to add one or two words. At most of our meetings—all, I think, for years past—it has been my good fortune to be able to propose a special vote of thanks to the management of this Company, I mean the executive management subordinate to the Directors. My friend, Mr. Andrews, you all know, and anything more from me with regard to his merits would be mere superfluity, but Mr. Andrews has managed to raise a body of gentlemen without whom even his talents would hardly avail us. The establishment originally was fixed, and I think most of the men in it were brought in by Mr. Weaver at the beginning of the Company. Mr. Andrews has continued with these gentlemen, and it is owing to the ability, industry and integrity of the staff generally that we have become so flourishing. I see before me two of the leading members of the staff, Mr. Moll, the accountant and secretary, and Mr. Pagenkopf, our chief clerk. With both of these gentlemen we are frequently brought into communication, and I may say better officers no company is blessed with. We have others, not here, to whom I may allude specially. I allude to the gentleman who superintends the maintenance of the line, Mr. Guenzel, and Mr. Nelson, our chief officer in Persia—a very trustworthy and valuable man, and I beg to ask you, gentlemen, to concur with me in a vote of thanks to Mr. Moll and the staff of the Company for their good services during the year.

Mr. STEFFEN: I have much pleasure in seconding that. I know great responsibility rests upon the executive and upon the officials of a company like the present. There is a large amount of work to be done, and the result is shown in the efficiency with which the work is carried out.

The resolution was put and carried.

Mr. MOLL: On behalf of myself and the other members of the staff I beg to thank you most heartily for the very kind way in which you have alluded to us. Our services have always been appreciated by the Directors and therefore as long as I and others are connected with the Company we will continue to do our best.

The CHAIRMAN: Gentlemen, the business of the meeting is concluded.

Mr. JACKSON: I beg to move a vote of thanks to our honourable Chairman. It is gratifying to receive a dividend of 10 per cent. There are other companies in which it is impossible, I am afraid, to hope for half that amount. I hope, sir, your life may long be spared to conduct, as successfully as it has been conducted hitherto, this Company. It is certainly a great satisfaction to shareholders to think that there is one Company of this kind which is paying 10 per cent. I have great pleasure in proposing a vote of thanks to Col. Holland for presiding, and for the services which he has rendered to the Company for so long a period.

Mr. STEFFEN: I have much pleasure in seconding that.

The resolution was carried.

The CHAIRMAN: Gentlemen, I thank you for your kind expressions, and I hope, as years go on, although I may not look forward to presiding on many future occasions, the Company may still go on and prosper as it has done.

The proceedings then terminated.

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The Maxim-Weston Electric Company (Limited).

An extraordinary general meeting of the shareholders in this Company was held in the Cannon-street Hotel on Thursday, to elect two additional Directors, and to fix the remuneration of the Board. Mr. Hugh Watt, M.P., the Chairman, presided.

The SECRETARY having read the notice calling the meeting,

Mr. GREIG asked under what clause of the Articles of Association the meeting had been called.

The CHAIRMAN replied that it was under Article 43, and as he had thought the question would be raised, they were prepared with an opinion, which the solicitor would read, whereby, even admitting—which he did not—that he had convened the meeting, he had the power to do so.

The SOLICITOR then read the decision of Lord Justice Mellish in a case (M'Dougal *v.* Gardner) that came before his lordship, the general effect of which was to establish the right of directors when any grave irregularity in the management of a company occurred, or when any dispute arose, to call an extraordinary general meeting of the shareholders.

Mr. GREIG pointed out, however, that the cases were not on all fours, because in the present instance nothing was disputed, and the meeting had been summoned on the responsibility of one Director, and therefore, as he maintained, illegally.

Mr. KLENCK pointed out that the first paragraph in the circular sent out by the Chairman calling the meeting said:—"A wish having been expressed by the general body of shareholders at a recent annual meeting that the Board of Directors should be strengthened," &c., and went on to challenge the Chairman to give the slightest proof of the expression of that wish. At the last meeting a resolution was carried to the effect "That sixteen of the largest shareholders, or as many of them as will agree to act in conjunction with the present committee, be appointed as a committee to report to the shareholders as to what is best to be done in the interests of the company, and to take the earliest opportunity to submit the same to the shareholders, five of such shareholders to form a quorum." In the face of that resolution, the Secretary promised immediately to communicate with sixteen of the largest shareholders, which he had not done. Instead of that, the circular signed by the Chairman had been sent to some of the shareholders—he said some because he had received a large number of communications from shareholders saying that they had not received it—calling this meeting, which he, therefore, considered to be illegal.

Mr. JOHN NEWTON also stated that the decision of the learned judge just quoted did not apply to the present case.

The CHAIRMAN said it might facilitate matters if they would content themselves to vote on the issue as to whether the meeting was legal or not (No, no). He denied altogether the imputation that they had not communicated with the largest shareholders, because he took care the very night after the last meeting to consult with a number of them. (Voices: "How many?" and "Name them.")

Mr. KLENCK, amid a scene of uproar, then moved that the names of the sixteen largest shareholders, or such shareholders as had been communicated with, be given to the meeting.

A SHAREHOLDER having seconded the motion,

The CHAIRMAN observed that whatever the meeting chose to do he had sufficient proxies to carry the motion he would propose. (Voices: "No, no; it is an illegal meeting.") He had already put the matter in the hands of a solicitor, and he intended prosecuting the committee of five shareholders that had been appointed.

Mr. GREIG: It does not matter, since Mr. Watt loses every action at law he takes up (laughter).

The CHAIRMAN said he was quite sure he would not lose this one.

Mr. KLENCK said there was a motion before the meeting, and he called upon the Chairman to put it.

The CHAIRMAN said Mr. Klenck held 50 shares, and Mr. Greig 100, while he (the Chairman) held between 8,000 and 9,000, and he would move an amendment to Mr. Klenck's motion.

Mr. GRIFFITH amid uproar endeavoured to remind the shareholders that at an extraordinary meeting the business must be confined to the resolution which it was called to consider, whereupon loud cries were raised that the meeting was illegally convened.

Mr. KLENCK and other shareholders insisted upon the solicitor to the company (Mr. Hawes) stating definitely whether it was a legal meeting or not.

The SOLICITOR said: In my opinion it is the best legal meeting we could have (laughter and cries of "Yes, or no.") In my opinion it is a legal meeting under the circumstances (renewed laughter).

Mr. JOHN NEWTON asked how one Director could call the meeting seeing that the other two members had left the Board.

The CHAIRMAN observed that the meeting was assuming that he called them together, whereas Mr. Brown (a Director) assented to his course of procedure. What he had said at the last meeting was that he would not interfere in any way with the *status quo* of the Board. He would not himself decide the question as between Mr. Brown and Mr. Swaby, because he felt he would occupy an invidious position if he did so. The result was that he had gone on the assumption that Mr. Brown and Mr. Swaby were still Directors. (A Voice: "That is too lovely;" and laughter.)

A SHAREHOLDER asked whether Mr. Swaby's resignation had not been accepted at a recent Board meeting.

The CHAIRMAN replied in the negative, but declined to enter upon the question (laughter and uproar). Certainly Mr. Brown's resignation was not accepted. He maintained, in opposition to what had been insinuated, that Mr. Brown was still a qualified Director.

After some remarks from Mr. JOHN NEWTON, in which he strongly protested that the meeting was illegally convened,

The CHAIRMAN asked the meeting to vote upon the question, a request which was immediately responded to by loud cries of "No." Under these circumstances he would ask permission to make a few remarks. He thought that every member of the committee and every gentleman present must agree with him that the Company at the present time was in a most anomalous position. So far back as not only the last general meeting in March, but the year before, he had intimated to the shareholders that as soon as arrangements were completed for carrying on the Company, he would resign his active connection with the Company. He wished to repeat to-day that as soon as matters were in good ship-shape he wanted to carry out that intention (hear, hear). His reason for that decision was mainly based upon his physician's opinion owing to a recent illness that he had had. He had no wish to remain as a Director in the Company longer than the moment when arrangements could be made for carrying on the business satisfactorily. Although they were unable to declare a dividend last year, he could assure them that the Directors had had harder work last year than in previous years, and the cause of that was attributable simply to the fact that the Weston machine could not be manufactured so cheaply as two other machines that were thrown upon the market during the last twelve months, and they had lost a good deal of business in consequence; and finding that they were losing ground in the matter of profits, he thought it was extremely desirable that they should have additional Directors, and if the shareholders put forward two good names, let it not be thought for a moment that he wanted to oppose their choice. On the contrary, he would be very glad to welcome them, although he had received an overwhelming number of proxies, whereby he could carry any resolution he put to the meeting ("No, no"). At the same time, he would not use those proxies if the shareholders ruled that the meeting was irregular, and he would also like to add that he did not ask for the proxies, they were sent spontaneously (laughter). He considered it desirable to call this meeting in the interests of the Company to extricate them from the very disagreeable position in which they were placed. He did not do so with any sinister motive, for he had already told them that he meant to resign (hear, hear). He had done more for the Company than any man had done for any other electrical company in England (laughter). He had paid £9,500 in dividends, and all the capital that the general public had subscribed had been £4,500. The Company three months ago occupied a good position, and he could have told them that it occupied that day a great deal better position than they seemed to imagine; but as they had declined to hear him, he would waive the matter. He stood to lose between £4,000 and £5,000 by the Company, and although he was willing to resign his position, as a business man he was not going to throw away his stock for nothing. But he would point out that since these meetings began the shares had gone down 1s. 6d., and afterwards 1s., and if they were to be continued the property would go down to nothing at all. If the committee or anybody else thought they could bring the shares up to 10s, why did they not send in nominations for the Board?

Mr. GREIG said there had not been time.

Mr. NEWTON observed that there had really been no committee.

[At this point the proceedings became exceedingly noisy, several shareholders attempting to speak at once.]

The CHAIRMAN, continuing, said he held a substantial stake in the Company, and whether he had an official connection with it or not he would always do everything he could to advance its interests. He had originally saved it from bankruptcy (oh). The gentlemen who said "Oh" could not be old shareholders, or they would know the facts. When he took over the Company 6d. could not be got for the shares. They knew very well that when Admiral Inglefield left the Board the shares went to almost nothing.

A SHAREHOLDER maintained that they were at 13s.

The CHAIRMAN: Then why did you not sell? (laughter).

Mr. MARKS said that no business could be transacted at the meeting, because he held in his hand the opinion of an eminent counsel (Mr. Chadwyck Healey) which said that any such business could be opposed by any individual shareholder.

The CHAIRMAN, after some further discussion, said that in order to simplify matters, if it was the wish of the shareholders that no meeting should be held, he would not stand in the way. All that he could say was that he regretted it, because the meeting was convened in the interests of the Company ("No, no"). To him it was a matter of no importance whom they appointed as Directors. He thought, however, that if, say, two Directors had been elected to act in conjunction with the committee, they would have arrived sooner at a *modus vivendi*. There would have then been a Board that would have secured contracts in the lighting of mansions, and so on—a branch of business which had not been much cultivated. With that object in view, he had been about to take upon himself to introduce one gentleman to their notice. He had been trying to get one or two of the most competent electrical and commercial gentlemen to take up the conduct of the Company, and he thought he had secured one of great ability, regarding whom his friend, Mr. W. H. Preece, and other authorities, had emphatically said that he would have been a great acquisition to the Company. And the proposal he (the speaker) would have made was this, that he would have taken upon himself to make a provisional arrangement with that gentleman, subject to confirmation, of course, by the new Board; but he found that the gentleman in question had been since engaged elsewhere, and what he wanted to point out now was that they would have arrived at some practical solution of their present difficult position if they had added two gentlemen to the directorate. If they did not accept that proposition the *status quo* remained, and the Company would be in a very anomalous and unsatisfactory position. They could not do any business at present. They had in view some large contracts—certainly one large one.

A SHAREHOLDER: Within the last few days?

The CHAIRMAN replied certainly within the last five weeks, and

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during the last week he had seen the people who asked for the tenders, and they said that they would not do anything until the matter now before the meeting was brought to an issue. He did, therefore, think that the appointment of two gentlemenn would be an advantage, but if the meeting was unanimous that the proceedings were irregular, he would not press the matter (hear, hear). Mr. Healey was, no doubt, a well known counsel, but they had the opinion of another which was opposed to that of Mr. Healey, and the shareholders would have to decide as between these conflicting views.

After some further animated discussion,

The CHAIRMAN declared the meeting dissolved.

An informal meeting of the shareholders was afterwards held, Mr. Klenck presiding, but the proceedings were strictly private.

Submarine Cables Trust.

Report of the Trustees to the seventeenth ordinary annual meeting of the certificate holders, to be held at the offices of the Trust, No. 50, Old Broad-street, London, on the 8th inst., at 2 o'clock :—

2. The revenue for this period, including the balance brought from the prevous accounts, viz., £95. 2s. 2d., amounted to £18,044. 0s. 6d.

3. The trustees regret that the Atlantic Cables competition referred to at the last annual meeting of the certificate holders still continues, and that, in consequence of the small return from their investment in Anglo-American Telegraph Stock, they are unable to meet the coupons of the Trust in full as they become due.

4. The balance of £1. 10s. which was left outstanding on the coupons due on April 15th, 1887, was paid on October 15th last, and the coupons which became due on October 15th, 1887, were liquidated on April 16th, 1888.

5. The expenses of the Trust amounted to £1,381. 5s. 1d., and the payments on account of the coupons to £15,214. 10s., together £16,595 15s. 1d., leaving a balance of £1,448 5s. 5d. to be carried forward. This balance is equal to 8s. 6d. per cent., which the Trustees propose to pay to the certificate holders, with a further amount to be taken from the current year's revenue, as soon as they have sufficient available funds to make a substantial payment on account of the overdue April coupons.

6. A table showing the original and present investments of the Trust is appended to the report.

7. The meeting will have to elect two auditors for the current year ; Mr. John G. Griffiths and Mr. John Gane offer themselves for re-election.

The Brazilian Submarine Telegraph Company, (Limited).

Report of the Directors for the half-year ended 31st December, 1887, to be submitted to the twenty-ninth ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, E.C., on the 9th inst., at 12 o'clock :—

The revenue for this period amounted to £102,594. 9s. 8d., and the working expenses to £12 812. 15s. 8d. After providing £12,880 for debenture interest and sinking fund, and £1,918. 1s. 9d for income-tax, there remains a balance of £74,983. 12s. 3d. ; to this is added £1,932. 12s. 3d. brought forward from 30th June last, making a total of £76,916. 4s. 6d. First and second interim dividends amounting to £39,000 have been paid, and £25,000 transferred to the reserve fund, leaving the sum of £12,916. 4s. 6d. to be carried to the next account.

In accordance with the provisions for repayment of the first issue of debentures, dated 31st July, 1884, 139 bonds representing £13,900 were drawn on the 26th April last, for payment at par on 31st July next. This, with the previous drawing, will make a total repayment of £51,000, leaving a balance of £99,000 on the first issue of debentures.

The ss. "Britannia" of the Telegraph Construction Company was employed in January last in repairing the shore end of the Lisbon-Madeira 1884 cable, which had been damaged by a severe storm. Whilst the ship was at Madeira it was considered desirable to remove a fault which existed in the Madeira-St. Vincent cable of 1874. Several miles of entirely new cable have been laid, replacing old cable on bad ground, which might have proved a constant source of trouble in consequence of rocky bottom. The cable recovered in deep water during the operations was found, after being submerged 14 years, to be in excellent condition both as regards the iron sheathing and the core.

The various sections of the Company's line are in good working order, with the exception of the St. Vincent-Pernambuco 1874 cable, in which a fault appeared on the 11th ult. ; this, however, in no way intereferes with the regular transmission of traffic by that cable. The fault being in shallow water some 21 miles from Pernambuco, no difficulty is anticipated when it is considered advisable to remove it.

West Coast of America Telegraph Company (Limited).

Report of the Directors to be submitted to the eleventh ordinary general meeting to be held at Winchester House, 50, Old Broad-street, E.C., on Wednesday, the 9th inst., at 1 o'clock :—

The balance-sheet and revenue account show a gross income of £57,893. 9s. 9d. for the year ended 31st December, 1887, against £43,026. 13s. 1d. for the previous year. After deducting debenture interest and all other charges there remained a net profit of £23,114. 18s 1d. for the past year, as compared with £11,037. 3s. for the year 1886. Adding the amount of £776. 16s. 5d. brought forward, the total sum to be dealt with was £23,891. 14s. 6d. Out of this the following dividends have been paid:—In July, 1887, 4s. per share, £6,000 ; in January, 1888, 6s. per share, £9,000 ; total, £15,000.

The Directors now recommend writing off £1,557. 15s. 3d. from the value of the repairing steamer "Retriever," thereby reducing her valuation in the books of the Company to £17,500, and to add £7,000 to the reserve fund, making the latter £27,000, which distribution will leave £333. 19s. 3d. to be carried forward.

The increased earnings of the Company are due to a large increase in the number of messages transmitted and—as far as the local traffic is concerned—to a small extent to an improvement in the rate of exchange.

The cables and repairing steamer are kept in perfect working order.

The members of the Board retiring by rotation are Mr. Alfred Marshall and Mr. Henry Roberts ; both are eligible, and offer themselves for re-election.

The auditor, Mr. J. Weiss, of Messrs. Turquand, Youngs and Co., retires, and is eligible for re-election.

NEW COMPANIES REGISTERED.

ASHWORTH BROTHERS AND COMPANY (LIMITED).—This company was registered on the 19th inst., with a capital of £10,000 in £10 shares, to carry on, at Manchester or elsewhere, the business of an electric light company in all branches, and to adopt an agreement of 13th ult., between Thomas Ashworth and Frederick King for acquiring a license of the patent right No. 4,081. The subscribers are :—

	Shares.
Thos. Ashworth, 29, Northumberland-street, Higher Broughton, Manchester	1
Henry Ashworth, Walsden, manufacturer	1
T. E. King, Lower Broughton, machinist	1
F. King, Salford, engineer	1
J. Whittaker, Higher Broughton, clerk	1
J. Sathers, Todmorden, surveyor	1
C. E. Hodden, Royton	1

THE BOURNEMOUTH ELECTRICITY COMPANY (LIMITED).—Registered by Hooper and Son, 69, Ludgate-hill, London, E.C. Capital £50,000, divided into 10,000 shares of £5 each. Objects : to enter into and carry into effect an agreement with Messrs. Phillips, Harrison and Hart, of No. 2, Victoria Mansions, Westminster, electrical engineers, of the one part, and the Bournemouth Electricity Company (Limited), of the other part ; to enter into and carry out contracts for lighting the town of Bournemouth with electricity, and maintenance of the same. The first subscribers are :—

	Shares.
H. Joy, landowner, Seamoor, Pool-road, Bournemouth	1
J. C. Harvey, Chaseley, Bournemouth	1
J. H. Moore, architect, Southbank, Bournemouth	1
E. Dyke, merchant, Southcote-road, Bournemouth	1
J. Kilmer, hotel-keeper, Highcliffe Hotel, Bournemouth	1
H. Patten, bank manager, Old Christchurch-road, Bournemouth	1
W. H. Dore, house proprietor, Bournemouth	1

The number of directors shall not be less than three nor more than 12, and the first shall be determined, together with the remuneration, by the subscribers to the Memorandum of Association.

TELEPHONE UNION (LIMITED).—This Company was registered on the 23rd inst., with a capital of £10,000,000, in £5 shares, to acquire patent rights and privileges relating to telephones or telephonic apparatus, and to take over the business property, goodwill and undertaking of any company, person or association, formed or empowered to carry on similar objects. The subscribers are : —

	Shares.
J. Morris, 6, Old Jewry, solicitor	1
James Brand, 65, New Broad-street, merchant	1
Frank Crisp, 6, Old Jewry	1
J. H. Brand, 65, New Broad-street	1
J. B. Morgan, Oxford-court, Cannon-street, managing director United Telephone Company	1
S. Edwards, J.P., 24, Fenchurch-street	1
Dillwyn Parrish, 2, Copthall-buildings, merchant	1

Registered without special articles.

THORNEBURRY LIGHT COMPANY (LIMITED).—This Company was registered on the 19th inst., with a capital of £20,000, in £5 shares, to acquire letters patent upon terms of an agreement with James Thorne, and to carry on the business of light and lamp manufacturers in all branches, whether in connection with electricity, oil, gas, or other modes of lighting, or for purposes of heat, motive power, &c. The subscribers are :—

	Shares.
James Thorne 85, Gracechurch-street, merchant	1
B. J. Danter, 17, Bishop's-road, Brixton, clerk	1
W. J. Hammond, 7, Chester-road, Upton-park, secretary to a company	1
E. H. Parke, Stanley-terrace, Deptford Lower-road, clerk	1
V. Bass, 179, King's-road, Camden-road, accountant	1
A. G. Brinkworth, 9, Alderbrook-road, Balham, clerk	1
W. H. Urry, 37, Leonard-street, Finsbury, clerk	1

The number of directors is not to be less than three, nor more than five; qualification 50 shares ; the subscribers are to nominate the first ; the company in general meeting will appoint remuneration.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The directors of this company notify the numbers of 139 Debentures of £100 each (1884 issue), which have been drawn for payment at par on 31st July next. The traffic receipts for the week ended April 27th, 1888, amounted to £4,222.

UNION ELECTRICAL POWER AND LIGHT COMPANY.—An order was made by Mr. Justice Chitty on Saturday for the compulsory winding up of this company.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended April 27th, 1888, after deducting the "fifth" of the gross receipts payable to the London-Platino-Brazilian Telegraph Company (Limited), were £3,524.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The directors of this company have decided to recommend to the shareholders at the approaching meeting that a dividend of 10s. per share be declared on account of arrears of dividend on the First Preference Shares.

PERSONAL.—Mr. V. S. Allpress, late assistant to Mr. W. H. Massey, and Mr. F. O. Belshaw, late of the Edison and Edison-Swan Electric Light Companies, announce that they have commenced business as electrical and mechanical engineers at 3 and 4, St. Margaret's Offices, Victoria-street, London, S.W.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.		Price, Wednesday, May 2, 1888.		Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending May 2, 1888.	
£			**TELEGRAPHS.**				£. s. d.		Highest.	Lowest.
1,770,860	Stock	5/0	Anglo-American	xd	38	39	3 9 6	Jan., Apr., July, Oct.	38½	38
2,614,820	Stock	10/0	Do. Preferred	xd	64	65	4 4 0	" "	65	64
2,614,820	Stock	nil.	Do. Deferred		12½	13½	...	February	13¼	13
130,000	£10	3/0	Brazilian Submarine		12¼	12¾	5 12 0	Mar., June, Oct., Dec.	12½	12 3/16
16,000	10	8/0	Cuba Submarine		12¾	13¼	6 1 0	February and August	13	12⅞
6 000	10	10/0	Do. Preference		19	20	5 0 0	" "	...	...
12,931	5	2½%	Direct Spanish (£4 paid)		3¾	4¼	3 10 0	March & September	...	...
6,000	5	5/0	Do. Preference		9	10	5 0 0	April and October ...	...	...
60,710	20	2/0	Direct United States		8⅝	8⅞	4 10 0	Jan., Apr., July, Oct.	8⅞	...
380,000	10	2/6	Eastern		11¾	12	4 12 9	" "	11 15/16	11 11/16
70,000	10	3/0	Do. 6 per Cent. Preference		14¾	15¼	3 19 0	" "	15	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899		108	111	3 16 3	February & August	...	...
250,000	10	5/6	Eastern Extension	xd & bonus	12¾	13	5 0 9	Jan., Apr., July, Oct.	12 15/16	12 11/16
22,050	10	8/3	German Union Telegraph and Trust		9	9½	7 7 4	January and March	...	...
179,177	10	2/0	Globe Telegraph and Trust		5⅞	6⅛	5 1 0	Jan., Apr., July, Oct.	6 1/16	5 15/16
178,992	10	3/0	Do. 6 per Cent Preference		13⅞	14⅛	4 5 0	" "	14⅛	13⅞
150,000	10	7½% '87	Great Northern	xd	14¼	14¾	5 0 0	Jan., July, and April	14¾	14 9/16
17,000	25	15%	Indo-European		38	40	6 5 0	April and October ...	...	...
38,348	10	3%	London Platino Brazilian		5½	6	5 0 0	May and November	5¾	...
9,000	8	4/0	Reuter's	xd	7½	8	5 0 0	April and October ...	8	...
338,225	Stock	15½%	Submarine		140	150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America		5¼	5¾	8 13 9	January and July ...	5¾	...
150,000	100	8%	Do. Debentures		112	117	6 16 2	June and December	...	...
88,321	10	nil.	West India and Panama		¾	1	...	...	15/16	⅞
34,563	10	10/0	Do. 1st Preference		10¾	11¼	8 8 9	April and October ...	11 1/16	11
45,181	15	3/9	Western Brazilian		10	10¼	6 4 6	March & September	10¼	9 15/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage ...	xd	118	123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds		101	103	5 16 6	March & September	...	...
			TELEPHONES.							
224,850	14/0	0/4½	Consolidated Telephone and Maintenance		⅝	⅞	5 0 0	Yearly	..	...
220,000	£1	...	Oriental (11s. paid)		¼	⅜	...	...	...	...
80,000	5	5/0	United		15¼	15⅝	4 2 6	June and December	15⅝	14 7/16
750,000	5	2/6	United River Plate		4⅞	5⅛	...	April and October ...	5	...
			ELECTRIC LIGHT.							
24,357	5	1/2 Feb.'86	Anglo-American Brush (£4 paid)		2¾	3¼	...	...	...	...
23,692	5	2/0 Feb.'86	Do. (fully paid)		3¾	4	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)		2⅜	2⅝	...	...	2½	2 7/16
312,000	½	5% '86	Maxim-Weston		1/16	3/16	...	February	...	...
			MISCELLANEOUS.							
87,350	12	36/0	Telegraph Construction and Maintenance		39½	40½	6 1 0	March and July	40½	39½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works		17½	18½	5 8 0	February & August	18	17½

PATENT

SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

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Hard Drawn High Conductivity Copper Wire.

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PHOSPHOR BRONZE

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